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MEMOIRS
OF THE
LITERARY
AND
PHILOSOPHICAL SOCIETY
OF
MANCHESTER.

See I

VOL. IV.

PART I.

MANCHESTER,
PRINTED BY C. WHEELER, FOR T. CADELL,
IN THE STRAND, LONDON.

MDCCXCIII.

1793



ADVERTISEMENT.

*THE appearance of the present half volume, demands an explanation from the Society.—A desire to fulfil its engagement with the public as far as circumstances would permit—and also to comply with an express law of great importance to its interests, have induced the Society to offer the present publication as the first part of a volume, which was promised to be brought forward every two years.—It is the intention of the Society to publish a second part early in the year 1794.—Unavoidable delays, occasioned by the pre-occupation of the press, and the dilatoriness of engravers, have protracted this first part of the fourth volume beyond the limited term.—The Society must again repeat, as a general declaration, that responsibility for the truth of facts, or justness of opinions, to be found in this or any future volume, rests with their respective authors. The favourable reception by the public of the former volumes of these *Memoirs*, at the same time that it demands the warmest acknowledgments of the Society, will serve powerfully to excite its future exertions.*

L A W S.

I. **T**HAT the Ordinary Members only shall be invested with the privilege of voting and electing Members, and that the whole expenses of the Society shall devolve upon them.

II. That Gentlemen residing at a distance from Manchester, shall be eligible into this Society, under the title of Honorary Members, provided no one be recommended who has not distinguished himself by his literary or philosophical publications.

III. That Gentlemen at a distance, who have favoured the Society with important communications, or from whom such contributions may be expected, shall be eligible, under the title of Corresponding Members.

IV. That every Candidate for admission into the Society, whether as an Ordinary, Honorary or Corresponding Member, shall be proposed by at least three Ordinary Members, who shall sign a certificate of his being, from their knowledge of him, of his character, or his writings, a fit person to be admitted into it; which certificate shall be read at not less than two successive meetings of the Society, previous to the election.

V. That no election shall be made, either of Ordinary, Honorary or Corresponding Members, except at the Quarterly

terly Meetings; and that notice shall be given to each Member, whenever a Candidate is nominated.

VI. That every election shall be conducted by ballot, and that the majority of votes shall decide; and that the president shall have the determining voice, if the number of votes be equal.

VII. That when an Ordinary Member removes to a greater distance than twenty miles from Manchester, he may be entitled to the continuance of the privileges of the Society, by paying five guineas to the treasurer, in lieu of his annual subscription.

VIII. That a President, four Vice-Presidents, two Secretaries, a Treasurer and a Librarian, be elected annually by the majority of Members present, on the last Friday in the month of April. The election to be determined by ballot.

IX. That a Committee of Papers shall be appointed by ballot, at the same time, which shall consist of the President, Vice-Presidents, Secretaries, Treasurer and Librarian, together with six other Members of the Society; and that this Committee shall decide by ballot concerning the publication of any Paper which shall have been read before the Society; and shall select, with the consent of the author, detached parts of any Paper, the whole of which may not be deemed proper for publication; but that the presence of seven Members of the Committee shall be necessary for such discussion or decision.

X. That Visitors may be introduced by any Member to the meetings of the Society, with the permission of the Chairman.

XI. That every Member who shall favour the Society with communications, shall send them to one of the Secretaries, the Monday before the meeting of the Society.

XII. That

XII. That the Secretary to whom the Paper shall be delivered, shall, with the approbation of the President, or two Vice Presidents, have the power of suspending the reading of it until it be referred to a meeting of the Committee of Papers, whose decision shall be final.

XIII. That all Papers judged admissible shall be read by one of the Secretaries, or by the author, in their order.

XIV. That no more than half an hour shall be allowed for the reading of any Paper, and if the whole cannot be read within that time, the remainder, except the Society determine otherwise, shall be deferred till the succeeding evening. No Paper however shall engage more than two evenings, without the consent of the Society, expressed by ballot, if required.

XV. That every Ordinary Member who produces a Paper, shall therewith deliver a summary of its leading contents, which shall be read, paragraph by paragraph, after the Paper, to regulate its discussion.

XVI. That the Speakers shall direct to the Chair any observations they may make; and, if it be difficult to command immediate attention, it is desirable that they should stand up, when they address the President.

XVII. That authors be requested to furnish the Society with an epitome of their Papers, which may be read at the meeting succeeding the reading of each Paper, and the discussion renewed.

XVIII. That each Ordinary Member shall pay one guinea annually, by half yearly payments, into the hands of the Treasurer, to defray incidental expenses, and to establish a fund for the benefit of the Society. Each Member on his election to pay his Subscription for the current half year, together with one guinea admission fee.

XIX. That

XIX. That each of the Vice Presidents, in rotation, undertake his office, for one month; during which term he shall take the chair, in the absence of the President, at seven o'clock precisely: It is hoped that he will furnish articles of intelligence; and when no paper is before the Society, it is expected that he provide a subject for discussion.

XX. That no Laws shall be enacted, rescinded or altered, but at the quarterly meetings, on the last Fridays in the months of January, April, and October; and that notice shall be given, at least fourteen days previous to those meetings.

XXI. That the Society shall publish a volume of miscellaneous papers, at least every two years. And that at stated times, the Committee shall select from the papers which have been read to the Society, such as shall appear to be most worthy of publication, but that no paper shall be published without the consent of the author. That every paper, voted for publication by the Committee of Papers, shall be sent to the press without delay; that notice of the printing shall be given to the author, and that he be entitled to thirty separate copies, on paying the extraordinary expense attending them.

XXII. That a Library be formed for the use of the Members of this Society, and that the Librarian be authorized to purchase such books as shall be ordered at the quarterly meetings of the Society; but that no book shall be taken out of the Library, without leave of the Librarian, limiting the time of keeping it to seven days.

XXIII. That the Resolution to establish a Library be announced to the Honorary and Corresponding Members of the Society; and that it be intimated to them by the Secretaries, that donations of their past and future publications will be *highly acceptable*.

XXIV. That

XXIV. That a GOLD MEDAL shall be given to the author of the most valuable experimental paper, containing some important discovery relative to the arts and manufactures of Manchester, which shall have been delivered to the Secretaries, and read at the ordinary meeting of the Society, before the last Friday in March 1794.

XXV. That the adjudication of this premium be referred to the Committee of Papers; that their decision shall be made by ballot, and that the medal shall be delivered by the President to the person to whom it shall have been adjudged, or to his representative, at the first meeting of the Society in October 1794.

XXVI. That two SILVER MEDALS shall be given *annually*, one to the author of the best Essay on a Literary, and another to the best on a Philosophical Subject, which shall have been read at the Society during the course of the season; to be determined by the Committee of Papers.

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MEMOIRS
OF THE
LITERARY AND PHILOSOPHICAL SOCIETY.

REASONS *for supposing that LAKES have been more numerous than they are at present; with an Attempt to assign the Causes whereby they have been defaced.*
By J. GOUGH, of KENDAL. — Communicated by
DR. PERCIVAL.

WHEN we consider what numbers of submarine productions are found in the bowels of the earth, we are in a manner compelled to conclude, that the present inhabitable parts of our globe have, at some unknown period, emerged from the bosom of the ocean; and, if we attend to the disorderly disposition of the strata, with other marks of violence which are every where to be met with, it is no less conspicuous, that

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this grand revolution has been produced by subterraneous convulsions. Why, then, are Lakes so few in number?—is a question which, at the first view, presents itself to the mind. Lakes are either depressions or chasms in the ground, where the waters of the neighbouring country are collected. And, if whole continents have been torn up, and have had their continuity every where broken, why are not cavities proper for forming such reservoirs more frequent?

This view of the subject certainly offers a formidable objection to the received theory of the formation of land, which ought to be attended to. I will therefore make it the business of the present essay to enquire, whether it can be fairly obviated by an attention to the resources of Nature, and to that gradual progress from a rude to a more perfect state, which she observes in all her works.

We know that the face of the earth is not now what it was formerly. Mountains, whose acclivities are at present easy and gentle, were once inaccessible through rocks and precipices. Large districts of land, which, at one period of time, were obstructed with fragments of stones, and buried in ashes, have been gradually fertilized by the remains of decayed vegetables, and the decomposition of volcanic substances. Some rivers have deserted their ancient channels, whilst others have been entirely lost. All these great changes have been effected without violence, by the action of slight but incessant

incessant causes: And why may not *lakes* have suffered injuries similar to those to which the other great works of creation are subject; and have been demolished or totally destroyed, like rivers, rocks, or volcanos?—that analogy of conduct and design, which pervades the whole visible system of things, at least authorizes the supposition.

We will therefore, *first*, enquire what means are in the possession of Nature for producing such a revolution; and, *then*, endeavour to discover, whether any proofs of such alterations having taken place are still extant. — This method of proceeding seems best calculated, either, to remove the objection, or to establish it.

Vegetation is a favorite process with nature: for she has not only clothed the plains and eminences with herbs and trees, but has also appropriated several species, and some whole genera to the water, for which element they are evidently intended by the singularity of their structure. Every part of a lake abounds with vegetables; where its depth will permit them to grow, and this circumstance is, for the most part, regulated by the variety of plants produced in it, and the climate where it is situated. — The sterility of deep waters depends on the following causes: Every plant must be placed in a situation where the temperance of the surrounding water never descends below a point fixed by the constitution of the plant; otherwise, it loses its vegetative powers. Successive and increasing degrees

of heat are, also, requisite for its growth and flowering. Add to this, that the temperature of the bottom of a lake is very different in different parts; because, as the depth of the water increases, its heat becomes less variable, being always nearly equal to the annual mean of the country: but the temperature of parts where the depth is inconsiderable is nearly as inconstant as that of the air. Such plants, therefore, as demand a degree of warmth nearly equal to that of the Atmosphere in summer, are always found in shallow places; such as are of a colder constitution fix their abode in deeper regions; but if any part of a lake be colder than the constitution of the coldest plant produced in it will bear, that part is necessarily barren.—Aquatic vegetables, at certain periods, lose their vegetative powers, in common with those that grow on land: But, while the latter are converted to earth, and afford additional fertility to the soil that raised them; the former preserve their figure, and, in part, retain their texture for ages; for water possesses an antiseptic virtue, that prevents the decomposition of vegetable substances immersed in it. When Julius Cæsar invaded Britain, the natives fortified a ford in the Thames, by driving pointed stakes into the bed of the river, with a view of retarding the progress of the Roman Army. A number of these stakes were preserved undecayed, undoubtedly by their situation, in the time of Rapin the historian, who wrote about the beginning of this century, To account for
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this antiseptic virtue, nothing more is necessary than to recollect, that water protects all bodies, covered by it from the injuries of the air. If a vegetable be thrown into this fluid, all its mucilage and gum will be soon extracted; but the resin, the woody fibre, and the cellular substance of the pith are not soluble in this element. Their decomposition, therefore, must entirely depend on fermentation, a process which cannot take place without a free exposure to the atmosphere, which communication is, in this case, precluded by the interposition of so unfavorable a *medium*. Few water plants acquire the properties of wood, unless the *cany* appearance of some grasses deserves the appellation; but they in general contain less mucilage, and more pith than others; consequently, their texture is less susceptible of injury from maceration. After having properly considered the foregoing observations, should any one survey a pond well stored with aquatic herbage, the following remarks can scarcely fail of receiving his approbation.

The cavity which is, at present, the receptacle of a pool, will, in process of time, be occupied by a *stratum* of solid matter, which will consist of the remains of its own produce gradually accumulated and preserved by the water which is intimately mixed with them, and which protects them from decay. The substance with which it is constantly filling will acquire a compactness nearly uniform in every part, by the plants
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of each generation interweaving their fibres with the remains of their predecessors; and by the depositions of the water, which, falling to the bottom, will be lodged in its interstices. All foreign bodies, brought hither by accident, will in time be buried in the increasing soil, where they will remain for ages, without undergoing any changes, besides those, which are produced by the solvent power of water on particular substances. Should the water be most shallow at the sides, and increase in depth as you advance to the middle, which is generally the case, the *margin* of the pond will be progressively advanced, and its *surface* contracted in proportion. If any part of it be too cold to favor vegetation, that part will still remain a pool surrounded with a flat, sedgey border. If it be supplied and emptied by two rivulets, the intermediate current will preserve itself a channel through the growing land. Lastly, the solid plain, thus produced, will, in time, be covered with a bed of vegetable earth, whose thickness will determine the difference of high and low water-mark; for the matter between those two limits, being alternately wet and dry, will, at particular periods, be exposed to the action of the air, and will, consequently, be decomposed, and changed into mold.

This method of converting a pond into land evidently points out a process that would diminish the inequalities of a disordered continent: And, if
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we leave speculation to compare the theory with what has passed in the world, we shall find every reason to believe, that the plan suggested by reflexion has been employed by nature in performing the business in question: For, it is upon this Principle alone, that we can account for the production of those flat marshes that supply many countries in the north of Europe with fuel. Several circumstances concur to demonstrate, that these swamps are indebted for their present appearance to the process described above; and perhaps it will not be improper to mention a number of facts in this place, that seem well calculated to establish the opinion. Could we remove from one of them all the peculiar soil whereby it is distinguished from the surrounding land, the cavity left after the operation would soon be converted into a lake; for in every bog there is a quantity of water always ready to occupy any depression that will answer the purpose of a reservoir. And, in fact, humidity is so necessary to the preservation of this kind of earth, that when it is exposed to the air it loses its distinguishing properties, and is changed into mold. There is another circumstance in which the works of Nature correspond accurately with the theory; for, in several marshes, very deep ponds are still to be met with. In some places they are open, and present themselves to the sight; but in others, they are dangerous pits, which are more or less concealed by a thin crust formed by aquatic plants, that float on the surface
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of the water without extending their roots to the bottom.

The matter of *Peat* is evidently of vegetable origin, as well as the treacherous covering mentioned above. The use to which it is commonly applied, shews that it is fit for combustion; and its ashes contain a quantity of fixed Alkali; which is rarely, however, pure, or free from mineral salts. If we examine its structure, it will be discovered to consist principally of flexible, branched fibres, variously interwoven, and twisted together. Their arrangement proves, that they grew where they are lodged; and that they were not brought into their present situation by any extraordinary agent, such as an inundation; for, had this been the case, instead of a compact substance, we should have found an incoherent mass of heterogeneous things, thrown loosely together without texture or connection. The lightest and most porous parts, being first saturated with humidity, would have descended to the bottom; whilst the more compact substances, being least capable of receiving an addition to their weight by imbibing water, would have remained in the highest place. Thus we should have found the materials of a swamp disposed in *strata* according to their texture and specific gravity, provided they had all been deposited at the same time in their present situation; which supposition cannot be true, because it is contradictory to Fact. The light, friable earth intermixed with these fibres has originated from the
decomposition

decomposition of such leaves as commonly float on the surface of every pool, and are exposed to the air. Their remains, being precipitated along with other accidental impurities, have subsided in form of mud, which has afterwards been covered with the vegetation of succeeding years. Such is the internal structure of marshes, where the produce of the original lake has alone been employed in their composition.

But since it is known, that they contain bodies, which are not natives of the water, foreign agents have certainly contributed to their formation: for, in digging for peat, several kinds of trees are discovered, lying horizontally, at different distances below the surface. They are commonly surrounded with the natural soil of the bog, and are rarely seen in contact with its bottom. From this circumstance it is evident, that the inferior part of the fibrous matter was formed before they came into the situation in which they are found. It frequently happens that they all lie nearly in one direction, and are confined to a particular part of the marsh. Some are found; others more or less decayed. Some are mutilated and broken; others, nearly entire. In fine, the entraneous matter of a swamp perfectly resembles the refuse of a river flowing through a woody country. In the north of England, it consists principally of oak, ash, fir, several species of willow, birch, and alder. Besides these, a great variety of ~~leaves~~ are dug up, with

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hazel

hazel nuts, the cones of birch and alder, a number of mosses, and some ferns. I think we may safely conclude, that these substances have been brought by rivers, after heavy rains, into the primitive lakes; or, that they have been blown, from off their branches where they grew, into the water; that the trees have then been driven by the wind, which, in sheltered places, can only blow in certain directions, into parts obstructed by weeds, and have there been entangled and prevented from moving till, their weight growing specifically greater than that of the fluid whereby they were supported, they have sunk in such a position, that the direction of the prevailing wind is commonly pointed out by the direction of their branches. The foregoing facts seem sufficient to shew how well the theory is supported by the evidence of nature. I will, therefore quit this part of the enquiry; but, before the subject is dismissed, will take the liberty of subjoining the following observations, which may perhaps be acceptable to the naturalist.

First: I have been informed by persons well acquainted with our marshes, that the yew makes a part of the fossil wood of the North of England; but it is so rarely found, that I have not hitherto been able to procure a specimen of it, though considerable endeavours have been made to obtain one, as such an acquisition would incontrovertibly prove the tree to be a native of this Island, a circumstance which has been disputed of late. But
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since those from whom my information was received had no interest in propagating a falsehood, their testimony may be relied on; and the yew will be found to have a very good claim to be accounted indigenous, because the abundance of fossil vegetables concealed in our marshes proves that they were formed when the land was over-run with wood. Britain, therefore, numbered the yew amongst her productions, before agriculture and the art of planting were known to her inhabitants.

Secondly: It is highly probable, that an observing person might easily determine to what *height* the hills of this island have been anciently covered with *wood*: for swamps are frequent on the sides of mountains, forming horizontal planes that interrupt their declivities. In some of these, which are much elevated, no trees are found; but I know a small one between two and three hundred yards above the level of the surrounding country, which abounds in *Birch*, and have been informed of another, where *Fir* is plentiful.

Thirdly: A thin bed of *peat* often covers the sloping sides of hills, where the ground is full of springs, but it differs in texture from the soil of *flat bogs*, as appears from the different methods observed in digging them: for the country people cut the latter horizontally; but, in working the former, they strike their spades perpendicularly down; otherwise the parts detached by this operation

ration would crumble to pieces; for the *stratum* consists of the roots of the *Juncus campestris*, heath, and other alpine plants connected in a very loose manner.

To return to the subject of the essay, it may be safely taken for granted, that the marshes of every country are similar to those of the north of England. Hence it follows that *Lakes* have once existed in every part of our Globe; and that they have been defaced by the same causes which have produced like effects in this part of the world. But nature is not confined to the process described above. She has other resources, which make a part of this inquiry, and still remain to be attended to. — In order to proceed with some degree of perspicuity, it will be necessary to premise the following circumstances, which must have attracted the notice of every one who has dedicated any part of his time to the examination of the phenomena observable in mountainous regions.

The compactest *strata* of the earth, when exposed to the atmosphere, are broken into pieces, as is evident from the immense heaps of stones which are found lying at the foot of every precipice, consisting of fragments that are continually detached from it by the injuries of the air, and have been accumulating for ages.

The truth of this proposition will be further confirmed by inspecting the side of a hill after the soil is taken away; for it appears to be made up of masses of
stone

stone of no determined size or figure; and the want of coherency is apt to give the observer an idea, that the whole eminence is constructed in the same loose manner. But, if the superficial rubbish be removed, the appearance of a solid rock will overturn the hasty conclusion. No kind of matter enters in any considerable proportion, into the *strata* of the north of England, that is proof to the injuries of the atmosphere. The *argillaceous saxa* are most susceptible of its influence; and even the lofty ridges of *limestone*, that are found in various parts of this county, are, in some places, so far demolished by the hand of time, as to be nearly buried in their own ruins. The knowledge of this method of decomposing the hardest substances in the world, enables us to explain in a very easy manner the formation of the deep channels, along which the rivulets of a mountain are conveyed from its summit to the neighbouring vallies. For these rills, which in dry weather are so insignificant as to glide unseen among the asperities of the hollows where they run, are liable to be converted by heavy rains into furious torrents that carry all before them. It is on these occasions, that the loose fragments of their stony bottoms are swept away, and driven to the lower ground, leaving a new surface of the rock exposed to the atmosphere, which in time is broken up by its action, and afterwards removed by the impetuosity of succeeding floods. The frequent repetition of these destructive operations has,

has, in some places, demolished the hardest *strata* to a depth scarcely to be credited. Now it is evident, that, where the same causes have been applied to the bank of a lake, they could not fail of producing the like effects as when exerted on the side of a hill. It may, therefore, be taken for granted, that the outlet of every lake has been more or less injured in the manner described above. This conclusion being admitted, the following consequences must immediately be assented to; because they depend on the simplest laws of Hydrostatics.

First: Wherever this process has taken place, the dimensions of the water contained in the reservoir always diminished as the depth of the channel increased through which the superfluous part was discharged.

Secondly: Its banks were gradually enlarged; and the inequalities of the basin began to rise above the surface, and assumed the appearance of islands.

Lastly: Wherever the situation of the discharging river would permit its bed to be worn to the level of the lowest part of the reservoir, the Lake has disappeared; and we find, at present, a valley in its room, containing very strong proofs of its own formation in the *stratum* of sand and pebbles with which its sides are covered. The particular situation of the outlet here alluded to depends on the figure of the bank where it is placed, which
must

must not only be steep, but its descent must also be continued lower than the basin, otherwise the lake cannot be totally defaced. For when a stream takes up a number of heavy bodies, it deposits them again as soon as its velocity begins to diminish; the largest first, and the less in succession, according to their bulks and comparative weights. Hence it appears, that the lower parts of the channel are continually rising from the accession of fresh materials; and the upper end is gradually depressed by the removal of the same, till the whole becomes a gentle declivity, down which the current will glide, no longer capable of disturbing the impediments lying in its way: consequently, the form and dimensions of its bed will become permanent. Now, if the lower mouth of a lake arrive at this state before it is sufficiently worn away, a part of its reservoir will for ever remain undrained, unless it happen to be deranged by violent causes; or to be filled up with sand and pebbles brought from the adjacent country, by the rivers which flow into it. After these destructive operations have ceased of themselves, there is reason to apprehend, from what has been discovered by Philosophers, that the same process would be continued with equal certainty, though not with equal effect, for the constituent particles of water are sufficiently hard to abrade the surfaces of very compact bodies; it having been proved by experiment, that the cohesion of glass itself is not strong enough to resist their action.

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The consideration of this fact would induce one to imagine, that the bed of a river undergoes insensible changes from the friction of its own stream, after it ceases to be exposed to the more manifest ravages of a torrent. But a little attention to the œconomy of nature will remove the suspicion, by pointing out a simple preventive, which she uses to obviate the inconveniency. For when a pebble has been a while deposited in water, it is covered with several of the *imperfect* plants, most commonly with the *conserva rivularis*, and different species of *tremella*. These singular productions of the vegetable kingdom are enabled by some peculiarities of their constitution to bear the friction of a stream without receiving the least injury: And, to whatever circumstance this property is owing, it is plain that the substances in question, while they provide for their own security, must ensure the protection of whatever they envelop. By spreading over every part in contact with the water, they preserve one continued surface, and present themselves entire and uninterrupted to the action of the current; and by occupying the crevices arising from the inequalities of contiguous stones, they form a kind of cement, in which the lighter fragments being entangled, are prevented from being moved by every trivial force. Thus is permanence given to the course of every river by this simple provision of nature; and bounds are set to a process, which without it must have been unlimited.

I have

I have now enumerated the various causes that contribute to the transformation of Lakes, by the gradual enlargement of their outlets, and have pointed out those circumstances, which in process of time unavoidably hinder future alterations of the kind. It will therefore be proper, in conformity to the plan of the essay, to confirm the truth of the theory by the following remarks, which I trust will not be found contradictory to the experience of any one, who has had an opportunity to make similar observations.

There are many vallies in the north of England, which, if we may judge from their appearance, have formerly been filled with water. The *coves* which seem scooped out of the sides of several hills are perhaps the most singular objects of the kind. The entrance into one of these places always lies through a narrow pass, between two steep banks. A rivulet most commonly flows through this opening, which, in some cases, conveys away the superfluous water of a basin lying in the centre of the natural amphitheatre. If the course of this stream be traced to some part where its declivity is interrupted by a plane, the observer may have an opportunity of discovering what has once been its employment. For he will frequently find it flowing along a channel considerably elevated by a broad bed of pebbles. The fragments constituting this ridge are in all probability the remains of a

rock, that formerly occupied the opening which is now the entrance to the cove.

Besides these, there are other vallies of greater extent, and more distant from the summits of the hills, which appear to be the worn-out reservoirs of ancient lakes. For, in them, the natural *strata* of the country are buried under deep beds of sand and pebbles. Their sides are frequently diversified with little eminences, which, in figure and structure, very much resemble the banks that are thrown up by currents: But their elevation above the neighbouring rivers forbids us to imagine that they were formed by them, as it is not uncommon to meet with small hills of the kind many yards above the limits of the greatest floods, but at the same time, it is evident that they have been raised by streams of considerable force, as they consist wholly of rolled stones, arranged in strata with beds of sand between them. The finest sand is found in the lowest and most sequestered places of these hollows, in such situations as theory assigns to it on the supposition that the bottom of a lake is the least agitated by storms, where the water is deepest.

In many places it is as small as that thrown up by the sea; but it differs in this respect—sea-sand is more or less mixed with shells, but this contains none, though the lime-stone that is often found in the neighbourhood abounds with them. From this fact it may be very properly inferred, that the matter in question is of a more recent date, than the

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the primitive strata of the surrounding country; and that the tides of the ocean were not concerned in lodging it where we now find it. For though it would be folly to seek for shells in the heaps of pebbles described above, because they would be unavoidably crushed to pieces, during the formation of these eminences, by the fragments of which they consist being thrown forcibly together by the currents; yet, it is equally evident, that the gentler undulations of the water would transport such light substances along with the finest particles of stone into the calmest parts of the reservoir, and there leave them to subside together. On this account it is highly reasonable to suppose, that the beds of sand here alluded to are not productions of the sea; but that they have been deposited by rivers, which, after running over strata in a state of decomposition, discharged all the impurities collected in their respective courses into vallies full of water at the time; and that the rubbish, which now covers their sides, consists of these impurities, disposed in their present order and arrangement, by the currents of the primitive lakes.

Kendal, June 16, 1790.

*An ARGUMENT against the DOCTRINE of MATERIALISM,
addressed to THOMAS COOPER, Esq. — By JOHN
FERRIAR, M. D.*

READ NOVEMBER 12, 1790.

AN TOTI MORIMUR? NULLAQUE PARS MANET
NOSTRI?

Senec. Troad. Act. 2.

WHEN you were employed, some time ago, my good friend, in subjecting the Doctrines of the Immaterialists to the terrible Ordeal of your Logic, you may remember, that in one of our conversations, I objected to the Material hypothesis those facts collected by Dr. Haller, which prove that great and extensive injuries have been many times sustained by the Brain, without detriment to the thinking faculty. You thought the objection inconclusive, and noticed it as such:* though not then aware of its full force, I was pleased to see it introduced by you; those important Cases (noticed by Dr. Haller for other purposes) being totally neglected, as far as I have observed, by every Writer on this question, but yourself.

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* Tracts, vol. 1. p. 181. Note,

It is natural to expect, that proofs which convince ourselves should also convince others; yet, though I consider the medical facts as almost demonstrating that the Brain is the Instrument only, not the Cause of the reasoning Power, I entertain no hope of their converting one thorough Materialist. Hypothesis is a Mistress not easily abandoned, and equally courted by Philosophers of both sides.

It is said of Democritus, that perceiving his figs to relish of honey, one day, he made a problem of the incident, and was proceeding to solve it, when his Attendant confessed that she had kept the figs in a pot which had formerly contained honey. The Philosopher was enraged, and complained that by this familiar explanation, he was deprived of a more important Cause of his own invention. Many writers seem to have inherited the spirit of the old Grecian, in the present Contest. They have run their Metaphysical career without stopping to enquire for facts, and there has been great sport, in the erection and demolition of the fanciful opinions which each party has brought into play;

— ὥς ὅτε τις ψάμαθον πάϊς ἀγχι θαλάσσης,
Ὅς τ' ἐπεὶ ἔν ποιήσει ἀθύρματα νηπιέχουσιν,
Ἄψ αὖτις συνέχευε ποσὶν καὶ χερσὶν, ἀθύρων.*

Your Philosophy is of mature age, and defies the application; but too many of the Materialists have reckoned their doctrine established, because
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* Homer, Iliad. xv.

some absurd theories of their Adversaries were overthrown; they have accumulated their strength against defenceless points; and have thought it a complete victory, to triumph, like Caligula, over rubbish and sand.

Great danger attends every step beyond direct inference, in reasoning concerning the facts of Neurology. Many of them tend to perplex, and many seem to contradict each other. But on the present question, though the facts are uncommon, they are complete; they cannot, therefore, be reckoned anomalous. And their authenticity would not be questioned even by a general reader, acquainted with the great names only of modern Philosophy, though they had remained unnoticed by MORGAGNI and HALLER.*

The Materialists deny the necessity of any thing more than the visible structure of the brain, to produce the act of thinking, in consequence of perception; but the contrary seems to be probable from these facts, which shew that, at different times, every part of that structure has been deeply injured, or totally destroyed, without impeding or changing any part of the process of thought. It is otherwise in the organs of Sense. When the parts of the Brain which, in common language, give origin to the Nerves supplying those organs, are injured,

* I have omitted a great number of facts, strongly in my favour, because the Authorities were not perfectly unexceptionable.

injured, the Senses are, in general, proportionably affected. This seems to point out a difference in the Causes of Thought and Sensation.*

Cases in which considerable parts of the substance of the brain have been lost, either by immediate injuries, or by suppuration following wounds and fractures of the Skull, are more numerous, than conclusive.† Neither will you make much account of them, as they chiefly relate to the hemispheres, and you seem‡ to make the basis of the brain the most essential part to perception, consequently, according to your scheme, to the process of thinking. Of this I am very glad, for a reason which shall be given afterwards.

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* Do not call this assertion extravagant, till you read the following Story, quoted by WEPFER.

“Mirabilis est capitis vulneratio, quam recenset *Valle-riola* Obs. Med. l. 4. obs. 10. de milite quodam, qui ænei tormenti globulum excepit in tempore sinistro, eo paulo altius egrediente ex opposito latere, distracto et dilacerato utrinque Cranio; qui citra apoplectica symptomata, miraculo integre curatus fuit, nisi quod *furdaster et cæcus manserit*. De loc. affect. in Apopl. p. 205.

I dare not transcribe the story of the Polish Nobleman which follows; (p. 206, 207) — the *ridiculum acri* may coalesce, but the *ridiculum vero* is a hazardous conjunction.

† V. Haller. Physiolog. T. 4. p. 316 et seq. and respecting the Cerebellum, Morgagni, Epist. lii. §27. Haller T. 4. p. 350 et seq.—Diemerbroeck Anatom. p. 582. Weyser Hist. Apoplecticor. (Ed. 1727) p. 208, 209.

‡ Tracts, vol. 1. p. 181. Note-

The late Dr. HUNTER was in possession of a skull, in which the bones of the Cranium, on the right side, were every where corroded. He had opened the head soon after the decease of the Patient, and found the whole of the right hemisphere destroyed by suppuration. Yet the man retained his faculties perfectly till the instant of his death, which was sudden.

Dr. HALLER mentions a case, in which half a pound of Pus was found in the ventricles of the brain; yet the faculties had been unimpaired till death.

Sir JOHN PRINGLE found an Abscess in the right hemisphere of the brain, as large as an egg, in a patient "who had never been delirious, nor altogether insensible;* and in another, who "had "never been so insensible, as not to answer reasonably when spoke to," he discovered an abscess of the Cerebellum, as large as a small pigeon's egg.†

LA PEYRONIE found pus lodged between the hemispheres, and compressing the Corpus Callosum: when the matter was evacuated, the patient recovered, without detriment to his faculties.‡

VESALIUS

* Diseases of the Army, p. 259.

† For a similar case, see Wepfer. Hist. Apoplest. p. 363.

‡ Memoir de l'Academ. de Chirurg. An. 1703.

VESALIUS found almost nine pints of water, in the brain of a girl only two years old. She had retained her senses perfectly till death.*

DIEMERBROECK, among other observations of the little effect produced on the mind, by wounds of the brain, mentions one which came under his own notice. A young Man received a thrust with a sword, in the inner Canthus of the eye, which passed through the right lateral ventricle, and slanting upwards, almost passed through the skull, at the upper angle of the Lambdoidal Suture: yet the Patient remained in his usual state of mind, "cum fociis convenienter et bono cum judicio quacunque de re differens," till the tenth day, when he was carried off by a fever.†

The same Author quotes a case from LINDANUS, of a patient, who, after receiving a wound in one

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* Morgag. de Caus. & Sed. Morb. p. 37, § 2. Wepfer. 56.

In one case mentioned by Morgagni, where the patient died, a month after falling on the head, and where the faculties were retained to the last, there was a curious affection of the brain: "Vix Dura detecta fuerat, cum animadversum est, in Cerebri hemisphærio sinistro tertiam anteriorem partem multo humiliorem esse sua compari, multoque molliorem, neque in summo tantum, sed ubique penitus ne basi quidem excepta. Scilicet ob eam Mollitiem ita subsederat: quæ Mollities cum in corticali substantia erat, tum multo majus in medullari. Hæc enim in quandam velut *gelatinam* magis ex parte mutata erat."

† Anatom. Lib. 3. p. 637.

of the lateral ventricles went about as usual, for a fortnight. He then died. It seems that his Surgeon thrust a probe into the ventricle daily, without exciting any sensation.*

A woman, under Diemerbroeck's immediate inspection, whose skull was fractured by the fall of a large stone, lost a quantity of brain equal in size to a man's fist, yet she lived thirty-six days after the accident, without alienation of mind, though paralytic on the side opposite to the fracture. On dissection, a considerable vacuity appeared on the right side (from which the portions of brain had been discharged) accompanied with suppuration, and extending through the lateral to the third ventricle, and to the Os sphenoides.†

The most remarkable case of this kind is quoted by La Peyronie: A child, six years old, received a pistol-shot in the head; a suppuration followed, during which he lost a great quantity of the brain at every dressing. At the end of eighteen days he died, having retained his faculties to the last. When the head was opened, the portion of Brain remaining in the skull did not exceed the size of a small egg.‡

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* In Dr. Haller's experiments on living Animals, the basis of the brain appeared to be the seat of Sensibility. *Physiolog. T. 4. p. 315.*

† *Anatom. p. 580, 1.*

‡ *Mem. de l'Academ. Ann. 1741.*

Left this narration should startle you, as La Peyronie, in the essay referred to, had a favourite spot which he wished to render the seat of the Soul, namely, the *Corpus Callosum*, suffer me to guard it by a similar quotation from the cautious MORGAGNI: “et si parietum lateralium ventriculorum crassitudo vi aquæ fuerat in quinquenni illo Tulpæ, non modo in trienni Hildani, aut bienni Vesalii, superné, & ad latera usque adeo extenuata, ut prima inspectione nulla esse videretur, cum instar alicujus crassioris membræ adhæresceret undique arcuatæ dissolutorum ossium circumferentiæ; nihil dubii est quin, &c.*

After reading these histories, you would be greatly surprized to find, in Mr. Pott's treatise on Injuries of the Head, that death has so often followed slight effusions and extravasations under the *dura mater*, preceded by comatose symptoms, and frequently by total insensibility. The contrast has often astonished me, but does not alter the nature of the facts; and only serves to shew the danger of analogical reasoning in Neurology, or perhaps, as a French wit has expressed

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it,

* Epist. Med. Anat. XII. Art. 8.—Consult some preceding passages, where he ascribes the apparent defect of brain in some fœtuses to a wasting caused by the continued pressure of effused water.

it, that Truth and Probability are not always of a side. *

On the faith of my Authors, then, I shall suppose it proved, that the thinking faculties have subsisted after the destruction of any superior or lateral part of the brain, and we will now consider, if you please, how far they have survived the depravation of the Cerebellum. To this purpose some examples are given by Morgagni†, but with such a truly Italian prolixity, that I am content to wave them, and to mention some that may be brought within the bounds of ordinary attention.

HALLER says, “non infrequentia ulcera Cerebelli
“sunt, etiam cum integritate mentis, morsque
“inde lenta, duodecimo die, aut multo serior,
“succedit.”‡ And he mentions several instances of Scirrhus affecting the Cerebellum, and producing death, without previously injuring the faculties. One case fell under his own inspection.||

In Morgagni's sixty-second epistle, art. 15, a particular account is given of a fatal Scirrhus of the Cerebellum, slow in its progress, not affecting the patient's senses till the last, and then only by intervals.

* This thought, by the way, is attributed to St. Jerome. (See Gent. Mag. Dec. 1786) — *Multa incredibilia reperies, et non, verisimilia, quæ nihilominus tamen vera sunt.*

† Epist. Anat. med. LII. Art. 26, 27.

‡ Element. Physiolog. p. 350,

|| Id. ib.

tervals. The whole Cerebellum was found diseased, though not equally.

The difference between the affection of the external and internal senses in the following case, where the pressure must have acted at least equally upon the Cerebellum as on the Cerebrum, is worth remarking.*

“ Vidit Clariss. Dom. Drelincurtius tumorem
“ steatomatis consistentia, pugnique magnitudine,
“ cerebrum et cerebellum inter, eó precisé loci
“ ubi conarium utrique substernitur choroidis plexus
“ alæ, spatio semestri a sensibili læsione, cæcitatem
“ primó, furditatem subinde, omnium denique
“ sensuum et functionum animalium abolitionem,
“ & necem ipsam intulisse.”†

Mr. PETIT speaks of a soldier, who received a musquet shot in the head; the ball passed through the left side of the Cerebellum, and penetrated into the left lobe of the left hemisphere of the brain. He survived the accident forty-three hours, and his faculties were perfect to the last.—Mem. de l'Academ. 1748.

We will now pass to the BASIS OF THE BRAIN, the inmost seat of reason, according to general opinion,

* Dr. Tyson mentions a case, in which the left hemisphere was found sphacelated, and the *testis* of that side greatly enlarged and stony. The patient had been ill for two months, and for the most part rational. (Phil. Transact. No. 228.)

† Addend. ad Wepfer. Hist. Apoplect. Obs. 83.

opinion, and certainly, as far as we may conclude from Dr. Haller's experiments, possessing a nicer degree of sensibility than the upper and lateral parts of the Mass: distinguished too, as whimsically in its different regions, by Anatomists, as the celestial Globe is divided by Astronomers.

* MORGAGNI relates the case of a Man, who died on the fourteenth day of a paralytic affection, having retained his senses during the greatest part of the time. On opening the head, and taking out the brain, a small quantity of purulent matter was observed in the basis of the skull; "qua
" absterfa, dum cerebrum tractatur, ibidem nova
" conspicitur. Nimirum per Infundibulum e
" ventriculis prodibat. Nam eadem sinister,
" dexterque præsertim redundabat. Quippe in
" hujus striato Corpore foramen erat, quocum
" ulcus sinuosum communicabat, tertiam partem
" occupans substantiæ, quæ a dextris basim cerebri
" faciebat."†

The following story, from TULPIUS,‡ deserves to be inserted entire. "Septuagenarius ebrius,
" delapsus ex altiori loco, contraxit in Calvaria
" tam

* I may refer you to Dr. Haller's Physiology for a collection of proofs (against La Peyronie) that diseases of the Corpus Callosum and Fornix do not affect the faculties. Tom. 4. P. 342.

† Epist. Anat.—Medic. v. Art. 2.

‡ Observ. lib. 1. Cap. 13.—Vide Addend. ad Wepfer. Hist. Apoplect. p. 583.

“ tam amplum vulnus, ut commodé per ejus
 “ hiatum educeretur quicquid inhæreret extimæ
 “ cerebri membranæ. Invadentibus ipsum nihil-
 “ ominus illic vertigine, vomitu ac stupore, five
 “ a residua crapula, five a concussio cerebro, sed
 “ *postridie rediit ad se, expers febris et immunis omnium*
 “ *aliorum symptomatum.* Verum die quarto, excreatis
 “ prius sputis purulentis, periit præter omnem
 “ spem, ab inopinata apoplexia.

“ Cujus ergo interiora capitis penitus perscru-
 “ tantibus, obtulit se primum frequens humor
 “ replens ventriculos cerebri: Sed mox longissima
 “ rima excurrens continuata serie, per frontem
 “ oculique foramen *usque ad sellam equinam,**
 “ *prope ossis cuneiformis medium:* quo loco ani-
 “ madvertimus (quod jure in omnium oculis
 “ fuit rarissimum) *ingens ossis Cuneiformis fragmen-*
 “ *tum,* ita sejugatum a reliquo osse, ut manifesté
 “ elevaretur supra quascunque partes circumpositas.
 “ Sed morbus attonitus, qui ipsum occidit, traxit
 “ originem partim ex obstructis processibus spinalis
 “ medullæ (qui sunt verum Nervorum principium)
 “ partim vero ex Angustia *retis mirabilis.* Quibus
 “ nobilissimis partibus impeditis privatur homo, non
 “ modo sensu ac motu, sed ipsa vita.” This is
 a tolerable stroke at the rational organization of the

basis,

* The *Pons Varolii* rests against the middle of the posterior clinoid processes which form one side of the Sella Equina, and the cuneiform process of the Os Sphenoidis.

† Sphenoidis scil.

basis, since the fracture of the Sphenoid bone, in that place, must have immediately given a great shock to the ~~Pons~~ Varolii, and the medulla oblongata; but I must bespeak your patience for the next quotation, which is at least as important. It is a Case of Dr. BRUNNER's in the APPENDIX to WEPFER. TRUTH distils slowly through TEUTONIC LATIN.

A Blacksmith, 64 years of age, a potent drinker, and industrious workman, (as Dr. BRUNNER tells us, in an eloquent periphrasis,) was struck down in a fit of Apoplexy on the 7th. of October, 1687, and expired immediately, though he had passed the morning in apparent good health. His faculties had never been impaired. The dissection you shall read in the Doctor's own words:

“ Serra fatis cautè inciso cranio scalproque effracto,
 “ dura mater circa frontem lacerata fuit leviter:
 “ revulsurus ollam, fatis firmiter sinui longitudinali
 “ adherentem, observavi piam matrem aqua
 “ limpida turgidissimam, instar hydatidis proruere,
 “ & vix cavi, quin dum auferebam cranium, subinde
 “ effluxerit aqua. Incisa dura matre nihil feri inter
 “ hanc & piam matrem inveni, quippe jam
 “ effluxerat. Sinus longitudinalis amplus, nihil
 “ humoris aut Sanguinis continuit, sed omnis
 “ refluxit versus sinus laterales fluidus. Ablata
 “ dura matre serum perpetim exsudavit et effluxit
 “ limpidum ---- uterque autem ventriculus aqua
 “ scatebat turbida, quin omnes recessus et cerebri
 “ cavitates

“cavitates hac inundatæ et repletæ fuerunt.
 “Plexus choroidei submersi albicabant, qui alias
 “rutilare conspiciuntur: hydatides aliquot in his
 “numeravi; ----- Infundibulum aqua
 “plenum, & reliquæ cerebri cavitates aquarum
 “illuvie inundatæ fuerunt, præsertim *quartus ventriculus*, ut immissus stylus ad spinam dorsi usque
 “dilaberetur. ----- Carotides aquis mersæ
 “albicabant. Cerebellum minime flaccidum, sed
 “sicut reliquæ cerebri partes firmum apparuit.
 “*Tota basis cerebri & ipsa spinalis medulla* aquarum
 “illuvie inundata fuit: stylus huic commissus ibat
 “in profundum per spinam dorsi. ----- certum
 “est omnes cerebri recessus & cavitates fuisse
 “repletas & distentas aqua; ipsam quoque spinalem medullam in suo involucro hac penitus
 “submersam observavimus.*

DR. BRUNNER adds, in the *Scholium*, that the man had been remarkably acute in his judgment. I observe that some facts of this kind had made an impression on WEPFER himself; for in his *Exercitation de loco affecto in Apoplexia*, he takes some pains to shew, against Riolan, that the faculties are not always injured by considerable collections of water in the Ventricles of the Brain.† Indeed,

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* Wepfer. Hist. Apoplect. p. 427.

See a history equally striking in the Addenda to Wepfer, p. 607.

† P. 54 (Edit. 1724) and seq.

in hydrocephalous cases, and in suppuration of the Brain, I have observed with astonishment, that the faculties were improving, as the fatal disease proceeded.

In the following case, related by DU VERNEY, though the condition of the basis of the brain is not clearly described, yet a considerable injury must have been done to it, by the fracture of the Os Sphenoides in the direction specified.

A Gentleman had his left eye crushed to pieces by a blow from a stone, and the orbit beaten in upon the brain. After the first shock, his faculties were entirely unimpaired, till his death, which happened on the seventh day; insomuch that some of his medical attendants pronounced it impossible that the brain should be injured; the appearances on dissection were these “ Le crane levé et le
 “ cerveau ouvert, nous le trouvâmes rempli d’une
 “ espece de bouillie qui n’étoit autre chose qu’une
 “ fonte d’une partie de la substance du cerveau
 “ avec quantité de petites esquilles qui avoient été
 “ poussées jusques là, ou par la violence de coup,
 “ ou par la suppuration. Toute la substance du
 “ Cerveau étoit également contuse et altérée jusqu’au
 “ cervelet; leurs Anfractuosités se trouvant se-
 “ parées les unes des autres par la dissolution et le
 “ relachement de la pie-mere. Enfin le cerveau
 “ étant oté, nous reconnûmes que la partie Ante-
 “ rieure de la selle de l’os Sphenoïde étoit toute
 “ ecrasée.”

"eclatée."* But whatever you may think of this story, you will find the next, from LA PEYRONIE, sufficiently particular.

A man, thirty years of age, who had been troubled with hypochondriacal symptoms for ten years, complained at times, during the last three months of his life, of heaviness and pain in his head, especially towards the occiput. Two days before his death, he was convulsed; but recovering, felt himself easier than he had been for a long time; the convulsion returned, and killed him in a quarter of an hour. His faculties were never affected. On dissection, the Ventricles were found dilated with water; "le plexus choroïde du quatrieme ventricule
"n'étoit qu'un amas de glandes fort gonflées et
"dures; il y en avoit quelques unes au milieu
"desquelles on trouvoit un petit noyau de sup-
"puration; elles étoient collées ensemble par leurs
"vaisseaux & par leurs Membranes; la reunion de
"ces glandes formoit une tumeur dure environ de la
"grosseur d'un œuf de poule, qui occupoit la place du
"cervelet, lequel n'étoit plus qu'une Membrane
"glaiseuse de l'épaisseur d'une ligne, et qui enve-
"loppoit la tumeur; les peduncules étoient
"extrêmement aplatis, et n'avoient presque point
"de consistance.

"Le corps étranger, soit par sa figure, soit par
"sa situation, avoit pressé, et beaucoup diminué

E 2

" la

* Memoir. de l'Academ. Roy. l'an 1703

“ la volume des testes, celui des cordons qui vont
 “ des testes au Cervelet, et les cordons qui vont
 “ du Cervelet à la Moëlle de l'épine, pour former
 “ la plume à écrire, enfin toute la portion de la
 “ Moëlle allongée, qui s'étend depuis l'ane et la
 “ Vulve jusqu' à la Moëlle de l'épine, étoit fort
 “ applatie”——

Look at the perpendicular section of the Brain, engraved in Dr. MONRO's treatise on the Nervous System, and you will perceive, that pressure in this direction must have produced a violent effect, on those parts which you seem inclined to reckon the most important, at the basis of the brain.

As to the *Pineal Gland*, it has so often been found suppurated,* or petrified,† or full of fabulous particles, without any previous affection of the faculties, that it seems to be given up as unnecessary to thinking, by general consent; and as Mr. SHANDY himself abandoned it,‡ I think it may pass for an untenable post.

HALLER quotes a case from Dr. RIDLEY, which I have not been able to verify by consulting the original, and as you well know the danger of giving implicit faith to quoted quotations, you will expect to see Haller's own words: “Ulcus Cerebri
 “ piam membranam et corticem ad medullam
 “ globosam

* Mem. de l'Acad. Royal. l'an. 1703.

† Manget. Theatr. Anatom. L. 4. C. 2.

‡ See Tristram Shandy, vol. II.

“ globosam usque erosit, absque dolore aut sensuum
“ læsione.”*

MORGAGNI mentions an apoplectic patient, who died on the ninth day from the attack of the disease; who was for the most part sensible; and who could describe, towards the last, the seat of his pain, in the hind-head, and along the spine. On opening the head, much water was found in the ventricles; grumous blood collected, where the medulla spinalis leaves the head, and many watery vesicles on the crura of the medulla oblongata.†

I should have placed little dependance on the collections of SCHENKIUS,‡ as most of his authorities are become very obscure, if they had not found credit in BONNET’S *Anatomia Practica*. Sheltered by such a name, I shall venture to extract one or two of them.

MASSA speaks of a Venetian Nobleman, who, though wounded in the back part of the head to the depth of three inches, preserved his faculties, and recovered completely.

Another

* Haller. *Physiolog.* T. 4. 338. *Ridleyi observ. Anatom.* p. 212: By the Medulla globosa, I presume, we must understand the Medulla oblongata.

† Morgag. *de Caus. et Sedib. Morb.* p. 14. § 20.

‡ *Observat. de Cerebro.*

Another of his patients received a wound from a halbert, which pierced to the *Os Basilare*:* he retained his faculties, but became epileptic, in consequence of a collection of pus being formed on the bone.

The wound of the Duke of Guise, mentioned by *Ambrose Paré*,† is still more extraordinary; yet *Paré*'s authority is very great. The Duke, says he, was wounded in the head by the thrust of a lance which entered under the right eye, near the nose, and came out at the neck, between the ear and the *vertebræ*. The steel of the lance remained in the brain, and was extracted with great difficulty. The patient recovered completely. *Paré*, I think, speaks of this case from his own knowledge.

But, to come still closer to the point, *BONNET* himself saw the structure of the basis wholly destroyed, in a patient who died after an illness of eleven days; who suffered no alienation of his faculties till within a very short period before his death, and was then only delirious at times, and perfectly sensible during the intervals. The appearances were striking. "*Tota fere basis cerebri*," says *Bonnet*, "*imprimis cerebellum, et ea pars Spinalis medullæ quæ*"
" *primis*

* There is an ambiguity in this word, as both the *Os Occipitis* and *Os Sphenoidis* have had this name applied to them, but from the expression, and the intimation of internal suppuration, I conceive the latter to have been meant.

† *Chirurg. Lib. 10.*

“ primis vertebris excipitur - - - - SPHACELO* in-
“ ventæ sunt correptæ.” †

The spinal marrow, where it leaves the head, has been seen greatly injured, in other cases, where no change in the thinking powers had been observed. ‡ It answers my purpose to remark, that in these different partial injuries, which we have followed round the brain, Reason has not been affected sooner than Life, but objections lie against the conclusion which I wish to draw from the facts.

The principal objection that occurs to me, is that the medullary fibres of the brain decussate and intermix with each other, on the Pons Varolii, and at the beginning of the medulla oblongata. || In consequence of this connection, it is easy to explain several phænomena in diseases, especially in palsies, which otherwise appear difficult; and in this way, it may be said, when one part of the brain is deeply injured, or destroyed, the loss of its activity is unfelt, because, in a healthy state, the opposite parts have formed a habit of interchanging impressions with each other. A simple encrease of activity,
therefore,

* That Sphacelus may take place in the brain, is allowed by Morgagni. *De Caus. et sed. Morb.* p. 50.

† Bonnet. *Anatom. Practic.* p. 42.

‡ Bonnet. *Id.* p. 352. *Ephem. Nat. Curios.* T. 6. Obs. 1723. Wepfer. *Hist. Apoplect.* p. 379.

|| See Winslow's *Anat. sub titulo.*

therefore, in the sound parts, may be supposed sufficient for continuing the mental functions. But this objection is, in the first place, inconclusive and hypothetical, for morbid affections may be transferred, as well as healthy ones; and this actually takes place, in those paralytic cases where the resolution of the nerves is perceived, in the side opposite to that on which the brain is injured. And the objection cannot be offered, against conclusions drawn from the histories of injury done to the basis of the Brain, where both sides of the Medullary substance, together with their connecting fibres, have been destroyed, without injury to the mind. It was on this account that I professed myself glad of your affixing such importance to the basis.*

Another objection, which I have heard started in conversation, is that a state of disease, in many of the Glands, is compatible, to a certain degree, with the exercise of their natural functions. To this I would answer, that I apprehend such an objection to be quite inadmissible, because it is an opposition of analogy to absolute facts: And of analogy very unsafe, for the brain is not known to be a gland. Even if the analogy and the objection were admitted, I do not know where any facts can be learned, that shall bring the assertion to an equality, with the degree of organic læsion compatible with the exercise of intellect. Chronic inflammation of
the

the Liver, which is attended with few and trifling symptoms, (though a fatal disease) is the only considerable instance that I recollect. This only proves, in conjunction with many other facts, the little sensibility of the liver, and consequently can be paralleled by no analogy with diseases of the basis of the brain.

Though many of the histories already noticed, afford examples of very extensive diseases in the head, yet the argument would press more strongly against Materialism, if it could be shewed, that Men can think, with little, if any portion of the Brain in a sound state. The following cases come nearer to this point than any I have heard of. In the dissection of a person who died apoplectic, and who had been dull and heavy before his death, *Tulpius* found the brain flaccid, and the membranes covered with a fluid, which it was necessary to take up with a sponge. The ventricles of the brain contained a great deal of water, and the spinal marrow was so drenched, that the operator was obliged to sponge it before he could examine into its condition.*^(a)

F

What

* Addend. ad. *Wepfer. de Apoplex.* p. 600.

(a) For the following very striking history, I am indebted to the kind communication of Dr. Percival. " — was
" born with a very large head; but seemed well in health,
" increased in strength, and grew fat. The head soon
" became so unnaturally large, and the features were so
" much altered, as to leave no doubt concerning the nature
" of

What PLATERUS saw, shall be told by himself:
 “ Ipsam adeo cerebri substantiam in Anu quadam
 “ defluxisse observavimus Monspeffuli, quæ *subitò*
 “ apoplexia tacta expiravit: hujus calvariam cum
 “ aperimus, cerebrum illius in Meninge crassa hinc
 “ inde fluctuare deprehendimus. Quod et dissecta
 “ aperta que dura dicta Matre, liquoris alicujus
 “ spissioris et albi pulsem referentis per faciem
 “ universam defluebat, et hinc inde in pannos
 “ dispergebatur.*

Of all the learned in us, whom I have quoted, I believe you have the greatest respect for BONNETUS; and it happens very luckily that the strongest fact to my purpose depends on his own observation. In a patient who died after an illness of twelve years, without having any alienation of mind, Bonnet found the whole substance of the brain watery, and so soft that it would hardly bear the knife. The
 spinal

“ of the disease. The child however increased in size, grew
 “ strong in his limbs, and took food. He could both hear
 “ and see well, and so continued until he was eighteen
 “ months old. He then died suddenly, without any con-
 “ vulsive attack. On opening the Cranium, more than
 “ *five quarts* of very limpid water were found within it;
 “ there was *not the smallest trace of membrane or brain*, except
 “ opposite the orbits and meatus auditorius, where some-
 “ thing like medullâ still remained.” Dr. Quin on Dropsy
 of the Brain. Append. p. 105.

* Addend. ad Wepf. p. 615.

spinal marrow was equally tender, and shrunk to half its natural size.*

An observation of the same kind came under my own notice very lately. A girl died in the fourth month of an Arthritic complaint, with evident symptoms of an oppressed brain, but in perfect possession of her intellectual powers. When the upper part of the skull was removed, before opening the Dura Mater, I was surprized at the flaccid appearance of the Brain; it did not seem to fill its Membranes, and it moved under the fingers with a very trifling resistance, so as to feel almost like a poultice.† We found the Ventricles quite full of water, and an effusion of blood upon the Tentorium, on the right side. But the principal disease seemed to be a total change in the consistence and colour of the Brain, throughout. It would scarcely bear either handling or cutting, and the parts were uncommonly indistinct.

On reviewing the whole of this evidence, I am disposed to conclude, that as no part of the Brain appears essentially necessary to the existence of the intellectual faculties, and as the whole of its visible structure has been materially changed, without affecting the exercise of those faculties, something

F 2

more

* Bonnet, *Anatom. Pract.* Tom. 1. p. 246.

† The Patient had not been dead more than twenty-four hours.

more than the discernible organization must be requisite to produce the phænomena of thinking.*

Thus, my dear friend, have I played off my small stock of quotations, against one point of your excellent Tracts; as Diogenes rolled about his tub, that he might not appear to be the only idle man in the City. I know that you will not misinterpret this attempt to furnish information, which medical writers only can supply, concerning a question which you have treated with so much clearness and precision. However we may have differed in opinion, concerning this, and other subjects of importance, we have always agreed in preserving good humour. And in such a contest, it will be honour enough for me to say with LUCIAN,† (but without intending a pun) *κεκύλισαι ὁ πῖθός 'εν Κρανίῳ.*

- * Tu semper fulges, divinæ particula auræ;
 Igneus ille tuus vigor et cœlestis origo
 Deformem Leti faciem, tenebrasque silentes
 Ridet, et æternæ spondet tibi sæcula vitæ.

Jortin. Lus. Poet.

† Lucian: *πως δέιν ἰστορίαν σύγγραφεῖν.*

COMMENTS ON STERNE. By. JOHN FERRIAR, M. D.
Read, January 21, 1791.

VOS ADESTE
RISUS, BLANDITIÆ, PROCACITATES,
LUSUS, NEQUITIÆ, FACETIÆQUE,
JOCI, DELICIÆQUE ET ILLECEBRÆ.

Buchanan.

THIS is almost the only satirical and ethical writer of note, who wants a commentator. The works of Rabelais, Butler, Pope, Swift, and many others, are over-loaded with explanations, while Sterne remains, in many places, unintelligible to the greater number of his readers. I would gladly discharge this debt of gratitude, to an Author who has afforded me much delight ; but my leisure hours can but produce some general traces, or occasional hints, that amount only to an amusing relaxation. Some person whose zeal is greater, and his literary repose complete, may work the mine I have opened, with profit and splendor.

Indeed, there is some danger in attempting to detect the sources, from which Sterne drew his rich singularities. It has been fashionable of late, to decry the analysis of objects of admiration, and those who wish to trace the mysteries of wit and literary

literary pleasure, are held to be profane dissectors, who mangle the carcase of learning, out of spleen and idle curiosity.* Besides, the originality of Sterne has scarcely been made a problem; on the contrary, he is considered as the inventor of a new style in our language. I cannot help thinking, however, with honest Mungo in the farce, that it imports us little to hear what we do not understand; and though far beneath the dignity of Horace or Pope,† who professed to admire nothing, I think it very unphilosophical, to let wonder conquer reason, especially in the closet.

To be too curious in the survey of beautiful performances, is to invite disgust. The colossal statues of Phidias, though polished to perfection without, bore a rude appearance to those who examined them

* It has been said, that a learned Gentleman intends to re-publish Joe Miller's Jests, with illustrations from the Greek writers. I expect impatiently the restoration of several of his Irish stories to Hierocles the Philosopher, from whose *Αἰεὶ* those ridiculous blunders have wandered abroad, and having lost their original country, are most unfairly quartered upon Ireland.

† Nil admirari prope res est una, Numici,
Solaque, quæ possit facere et servare beatum.

Hor. Ep. Lib. 1. Ep. vi.

For fools admire, but men of sense approve.

Pope,

within:* but if a limb, or a feature of a work, should appear to be purloined from the labours of a former artist, it would be right to look for his mark.

In tracing some of Sterne's ideas to other writers, I do not mean to treat him as a Plagiarist; I wish to illustrate, not to degrade him. If some instances of copying be proved against him, they will detract nothing from his genius, and will only lessen that imposing appearance he sometimes assumed, of erudition which he really wanted.

It is obvious to every one, who considers Tristram Shandy as a general Satire, levelled chiefly against the abuse of speculative opinions, that Rabelais furnished Sterne with the general character, and even many particular ideas, of his work. From that copious fountain of learning, wit and whim, our author drew deeply. Rabelais, stored with erudition, poured lavishly out, what Sterne directed and expanded with care, to enrich his pages.

* ἐκείνων γὰρ ἕκας τὰ ἐκτ', ὁ μὲν Ποσειδῶν, ἡ Ζεὺς ἐςί πάγκαλ', χρυσὸν καὶ ἐλέφαντ' ξυναργασμέν', ***
**** ἣν δὲ ὑποκύψας ἰδὼς τὰ ἐνδοθεν, ὄψει μοχλεῖς τινας, καὶ γόμφους, καὶ ἥλας διαμπὰξ πεπερωνημένους, καὶ κορμούς καὶ σφῆνας, καὶ πίτταν ὑπόπηλον, καὶ τοιαύτην τινὰ πολλήν ἀμορφίαν ὑποκίευσαν.

Lucian. Ονειρ : ἡ Ἀλκυονες :

pages*. And to this appropriation, we owe many of his most pleasing fallies. For being bounded in his literary acquirements, his imagination had freer play, and more natural graces. He seized the grotesque objects of obsolete erudition, presented by his original, with a vigour untamed by previous labour, and an ardour unabated by familiarity with literary folly. The curious Chapters on Noses† afford the strongest proof of this remark. About the
time

* καθάπερ ἐν πολλῶν νημάτων εἰ τις κομίσας ῥῆυμα τι, εἰς τὴν ψυχὴν μετοχτεύσει.

Dionys. Halicarn. Αρχ: Κρις :

† Sterne would have made much of a passage in the Memoirs of La Porte: it respects the views of *Mademoiselle* to a marriage with Louis 14th.—“ Je dis “ tout cela à la Reine, qui se mocqua de moi, me disant: “ ce n’est pour son nez, quoiqu’il soit bien grand.”—

Mem. de la Porte, p. 275,

The following precious anecdote on this subject, occurs in the curious Miscellany published under the assumed name of Vigneul Marville: “ Les nés camus déplaisent, et “ font de mauvaise augure. Le Connétable Anne de “ Montmorency étoit camus; et on l’appelloit à la Cour, “ le Camus de Montmorency. Le Duc de Guise, fils “ de celui qui fut tué à Blois, étoit aussi camus; et j’ai “ connu un Gentilhomme qui ayant une vénération singulière pour ces deux Maisons de Guise et de Montmorency, ne se pouvoit consoler de ce qu’il s’y étoit “ trouvé deux camus, comme si ce défaut en diminueoit le “ lustre.” Tom. 1. p. 140,

“ He”

time when Sterne wrote, it was not forgotten indeed, that the physiognomy of the Nose had been a kind of fashionable subject among Philosophers; but little was written, and little remains on the controversy, and what Sterne gives us, is founded on the following passage of Rabelais: "Pourquoy, " dit Gargantua, est ce que frere Jean a si beau " nez? Par ce (repondit Grangousier) qu'ainsi " Dieu l'a voulu, lequel nous fait en telle forme, " & telle fin, selon son divin arbitre, que fait un " potier ses vaisseaux. Par ce (dit Ponocrates) " qu'il fut des premiers à la foire des nez. Il " print de plus beaux & des plus grands. Trut " avant (dit le moine) selon la vraye Philosophie " Monastique, c'est, par ce que ma Nourrice avoit " les tetins molets, en l'allaitant, mon nez y " enfondroit comme en beurre, et la s'eslevoit et " croissoit comme la paste dedans la mets. Les " durs tetins des Nourrices font les enfans camus. " Mais gay, gay, ad formam nasi cognoscitur ad " te levavi."*

G

" Now

" He" (Mr. Shandy) " would often declare, in speaking his thoughts upon the subject, that he did not conceive how the greatest family in England could stand it out against an uninterrupted succession of six or seven short noses."—Trist. Shandy, vol. 3. chap. 33. This is a curious coincidence; I pretend to call it no more.—But it must be added, that Marville's Miscellanies appear to have been much read, about the time when Sterne wrote.

* Liv. 1. Chap. xli.

“ Now Ambrose Paræus convinced my Father
 “ that the true and efficient cause of what had
 “ engaged so much the attention of the world,
 “ and upon which Prignitz and Scroderus had wasted
 “ so much learning and fine parts—was neither this
 “ nor that—but that the length and goodness of the
 “ nose, was owing simply to the softness and flac-
 “ cidity of the nurse’s breast—as the flatness and
 “ shortness of puffed noses was, to the firmness and
 “ elastic repulsion of the same organ of nutrition
 “ in the healthy and lively—which, though happy
 “ for the woman, was the undoing of the child,
 “ inasmuch as his nose was so snubbed, so rebuffed,
 “ so rebated, and so refrigerated thereby, as never
 “ to arrive ad mensuram suam legitimam;—but that
 “ in case of the flaccidity and softness of the nurse
 “ or mother’s breast—by sinking into it, quoth
 “ Paræus, as into so much butter, the nose was
 “ comforted, nourished, &c.”*

“ — the causes of short and long noses. There
 “ is no cause but one, replied my uncle Toby,—
 “ why one man’s nose is longer than another’s, but
 “ because that God pleases to have it so. That is
 “ Grangousier’s solution, said my Father.—’Tis
 “ he, continued my Uncle Toby, looking up,
 “ and not regarding my father’s interruption, who
 “ makes us all, and frames and puts us together, in
 “ such

* Tristram Shandy, vol. iii. chap. 38.

“such forms and proportions, and for such ends,
“as is agreeable to his infinite wisdom.”*

I wish Sterne had known enough of Taliacotius to have done him justice, on the subject of noses. The practice of that extraordinary man, which has been obscured by misplaced raillery, and the imputation of follies entirely foreign to his method, deserves to be better known.† It was both rational and successful; and it is a considerable addition to his fame, that he anticipated later Physiologists in some surprizing and important facts respecting the re-union of living parts.—Sterne has played unaccountably with the public curiosity, on the subject of a very silly book, which he attempts to pass off as curious, merely because it is obscure. This is the more surprizing, because his fiction of Slawkenbergius is admirable. Mr. Shandy has the good fortune, we are told, to get *Bruscambille's Prologue on Noses* almost for nothing—that is, for three half crowns.“ There are not three *Bruscambilles* in Christ-
“endom—said the stall-man, except what are
“chained up in the libraries of the curious.”—This is well calculated to excite the appetites of epicures in literature, which perhaps was all the Author intended; and which is ill supported by the work in question. That no future Collector

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may

* Id. Chap. 41.

† See his Book, De Curtorum Chirurgia.

may sigh for Bruscambille, I will give as much of his Prologue on Noses as deserves the patience of a Reader. I shall only premise, that the book consists of a set of prose discourses, printed at Cologne, in 1741, which seem to have ushered in comedy,* farce, or puppet-show, according to the exigencies of the night: they resemble the Prologues of Terence, only in the freedom with which Mons. Bruscambille treats his audience.

“ Je n'entreprend point de faire ici une ample
 “ description des differens nez, avec les proprieté
 “ singulieres qui leur sont annexées; j'en dirois
 “ peut etre trop des grands nez au préjudice des
 “ nez mediocres, des petits nez, des nez cornus,
 “ des nez plats, & autres de toute sorte d'espece;
 “ je me contente de dire que les grands nez ont
 “ beaucoup d'avantage sur les petits pour les odeurs
 “ dont ils sont l'organe naturel, d'autant que par
 “ leur capacité plus étendue ils peuvent recevoir
 “ plus de vapeurs odoriférentes & que celles qui
 “ montent de bas en haut leur peuvent moins
 “ échapper qu'aux petits nez: en un mot, Messieurs,
 “ si c'est quelque chose de beau, de bon, de louable,
 “ d'avantageux en tout genre d'avoir du nez, il le
 “ doit

* The first is entitled, *Premier Prelude, en forme de Galimatias, pour l'ouverture du Theatre*. Several others are said to be *en forme de Galimatias*, but the specification was needless.

“ doit être encore plus d'avoir du grand nez,” &c. Jam fatis.*

The mock quotations, explanatory of the *Promontory of Noses*, in Slawkenbergius's tale, are merely designed to cover the use made of Rabelais's proverb; “ il fut à la foire des nez.” Sterne has diverted himself sometimes with references to some parts of this author, that appear ænigmatical enough. For instance; “ Who was Tickletohy's Mare?”† I believe many of Rabelais's readers would be puzzled to answer. Sterne alludes to the story of poor Tappecoue,‡ who fell a sacrifice to the resentment of the devils of Poictiers.

At other times, Sterne indulges in all the Galimatias of the old Frenchman. —“ Bon jour! “ good morrow!—so you have got your cloak on “ betimes! but 'tis a cold morning, and you judge “ the matter rightly—'tis better to be well mounted “ than go o' foot—and obstructions in the glands “ are dangerous—And how goes it with thy Con- “ cubine—thy wife—and thy little ones o' both sides? “ and when did you hear from the old gentleman “ and lady,” &c.‖

I believe

* Pensées Facétieuses de Bruscambille. P. 48.

† Chap. 36. vol. ii. Tr. Shandy.

‡ Rabelais, Liv. IV. Chap. XIII. That strange fellow, Sir Thomas Urquhart, the Romancer of Crichton, translates this word, Tickletohy.

‖ Vol. viii, Chap. 3.

I believe this brilliant passage is founded on the Prologue to Rabelais's fourth Book. Some of Sterne's other imitations do him more credit; but in the eighth volume of *Tristram* he was not very nice in taking assistance. "Gens de Bien, says Rabelais, "Dieu vous sauve et gard. Ou estes vous? je ne peux vous voir. Attendez que je chauffe mes lunettes. Ha, ha, bien & beau s'en va Quaresme, je vous voy. Et doncques? Vous avez eu bonne vinee, a ce que l'on m'a dit. "---- Vous, vos femmes, enfans, parens et familles estes en fantè desirée. Cela va bien, cela est bon, cela me plaist—" &c. Certainly this trash must be one of those passages, escaped, as Rabelais declares that he wrote 'en mangeant et buvant,' after he had taken a cup too much.

Perhaps it would do violence to the analogy, to say that the exquisite dialogues, scattered through *Tristram Shandy*, took any colour from those delivered by Rabelais.—At least, it would appear to be refining too far. Yet the contrast and contention of characters and professions so striking in both romances; the strong ridicule thrown upon the love of hypothesis; and the art with which absurdities in every walk of science are exposed, have always impressed me with a general idea of resemblance; and have recalled Pantagruel, Panurge and Epistemon, in many of the Shandean conversations. If there be any degree of imitation in this respect, it is greatly to Sterne's honour. A higher polish was
never

never given to rugged materials. But there can be no doubt respecting Sterne's obligations to another Author, once the favourite of the learned and witty, though now unaccountably neglected. I have often wondered at the pains bestowed by Sterne, in ridiculing opinions not fashionable in his day, and have thought it singular, that he should produce the portrait of his Sophist, Mr. Shandy, with all the stains and mouldiness of the last century about him. For the love of scarce and whimsical books, was no vice of the time when Tristram Shandy appeared. But I am now convinced, that all the singularities of that character were drawn from the perusal of *Burton's Anatomy of Melancholy*; not without reference,* however, to the peculiarities of Burton's life, who is alledged to have fallen a victim to his astrological studies. We are told, accordingly, that Mr. Shandy had faith in astrology.†

The *Anatomy of Melancholy*, though written on a regular plan, is so crowded with quotations, that the reader is apt to mistake it for a book of common-places. The opinions of a multitude of Authors are collected, under every division, without arrangement, and without much nicety of selection, to undergo a general sentence; for the bulk of the materials

* Even the name of Democritus junior, affected by Burton, may have led to Sterne's assumption of the title of Yorick. Burton too was a Clergyman.

materials enforces brevity on the writer. In the course of a moderate folio, Burton has contrived to treat a great variety of topics, that seem very loosely connected with his subject; and, like Bayle, when he starts a train of quotations, he does not scruple to let the digression outrun the principal question. Thus, from the Doctrines of Religion, to Military Discipline; from inland Navigation, to the Morality of Dancing Schools, every thing is discussed and determined. The quaintness of many of his divisions seems to have given Sterne the hint of his ludicrous titles to several Chapters;* and the risible effect resulting from Burton's grave endeavours, to prove indisputable facts by weighty quotations, he has happily caught, and sometimes well burlesqued. This was the consequence of an opinion, prevalent in the last age, which a late writer has attempted to re-establish respecting History; that authorities are facts.

But where the force of the subject opens Burton's own vein of Prose, we discover valuable sense and brilliant expression. The proof of this will appear in those passages, which Sterne has borrowed from him without variation. Burton was likewise a Poet; a copy of verses in Latin, and another in English, prefixed to his book, afford no mean proofs of his

* The Tale of a Tub, and the Memoirs of Scriblerus, must come in for a share of this influence.

genius.* The Anatomy of Melancholy has always been a source of surreptitious learning; Anthony a-Wood speaks of it, as a compilation highly useful to Gentlemen who were negligent at College; and Archbishop Herring alledged that the wits who flourished under Queen Anne and George the First, were under great obligations to it.† In

H literature,

* The late Mr. Warton, in his edition of Milton's Smaller Poems, has noticed the analogy between these English verses, and the Allegro & Penferoso. Burton alternates them, thus:

When I go musing all alone,
Thinking of divers things fore-known,
When I build Castles in the air;
Void of Sorrow, void of Fear,

Pleasing myself with phantoms sweet,
Methinks the time runs very fleet.

All my joys to this are folly,
Nought so sweet as melancholy.

When I go walking all alone,
Recounting what I have ill done,
My thoughts on me then tyrannize,
Fear and sorrow me surprize;

Whether I tarry still or go
Methinks the time moves very slow.

All my griefs to this are jolly,
Nought so sad as melancholy, &c.

There is a direct imitation of these verses in Voltaire's
'Jean qui pleure, et Jean qui rit.'

† Biograph. Dict. Art. Burton (Rob.)

The story of Dr. Parnell's beautiful allegory on Man, is taken from Burton, p. 64.

literature, the springs are commonly more copious than their derived streams, and are therefore more highly honoured. But though this applies to Burton, and most of his imitators, it fails in respect of *Tristram Shandy*, where, though much is directly drawn from our Author, there are many delightful windings, widely distant from his influence. I would therefore beware of imitating the rashness of a Traveller, who should fancy he had discovered the secret head of a mighty river, while, deceived by imperfect intelligence, he had only explored the source of an auxiliary stream.

The first four chapters of *Tristram Shandy*, are founded on some passages in Burton, which I shall transcribe. Sterne's improvements I shall leave to your recollection.

“ Filii ex senibus nati raro sunt firmi tempera-
 “ menti, &c. Nam spiritus cerebri si tum malè
 “ afficiantur, tales procreant, & quales fuerint
 “ affectus, tales filiorum, ex tristibus tristes, ex
 “ jucundis jucundi nascuntur [Cardan.] “ If she”
 (the mother) “ be over-dull, heavy, angry, peevish,
 “ discontented and melancholy, not only at the
 “ time of conception, but even all the while she
 “ carries the child in her womb (saith Fernelius)
 “ her son will be so likewise, and worse, as Lem-
 “ nius adds, &c. - - - - So many ways are we
 “ plagued and punished for our fathers defaults;*”
 “ infomuch

* This idea runs through *Tristram Shandy*.

“ infomuch that as Fernelius truly faith, it is the
 “ greatest part of our felicity to be well-born, and
 “ it were happy for human kind,* if only such
 “ parents as are sound of body and mind, should be
 “ suffered to marry. Quanto id diligentius in
 “ procreandis liberis observandum.”† I cannot help
 thinking, that the first chapter or two of the
 Memoirs of Scriblerus whetted Sterne’s invention,
 in this, as well as in other instances of Mr. Shandy’s
 peculiarities.

The forced introduction of the sneer at the term
 non-naturals,‡ used in medicine, leads us back to
 Burton, who has insisted largely and repeatedly,
 on the abuse of th functions so denominated.

It is very singular, that in the introduction to
 the Fragment on Whiskers, which contains an evi-
 dent Copy, Sterne should take occasion to abuse
 Plagiarists. “ Shall we for ever make new books,
 “ as Apothecaries make new mixtures, by pouring
 “ only out of one vessel into another?” Ex ore

H 2

tuo

* See Tristram Shandy, Vol. viii. Chap. 33.

† Anat. of Melanch. p. 37. Edit. 1676.

Quanto id diligentius in liberis procreandis cavendum,
 fayeth Cardan. Trif. Shandy, Vol. vi. Ch. 33.

‡ Tr. Sh. Vol. i. Chap. 23.—“ Why the most natural
 actions of a Man’s life should be called his non-naturals, is
 another question.”—See Burton, p. 39. The solution might
 be easily given, if it were worth repeating.

two—" Shall we be destined to the days of eternity,
 " on holidays, as well as working-days, to be
 " shewing the relics of learning, as monks do the
 " relics of the r saints—without working one—one
 " single miracle with them?"—Here we must acquit
 Sterne: he has certainly done wonders, wherever
 he has imitated or borrowed.—

" One denier, cried the order of mercy—one
 " single denier, in behalf of a thousand patient
 " captives, whose eyes look towards heaven and
 " you for their redemption.

" ——— The Lady Bauffiere rode on.

" Pity the unhappy, said a devout, venerable,
 " hoary-headed man, meekly holding up a box,
 " begirt with iron, in his wither'd hands—I beg
 " for the unfortunate—good, my lady, 'tis for a
 " prison—for an hospital—'tis for an old man—a
 " poor man undone by shipwreck, by suretyship,
 " by fire—I call God and all his angels to witness—
 " 'tis to clothe the naked—to feed the hungry—
 " 'tis to comfort the sick and the broken-hearted.

" ——— The Lady Bauffiere rode on.

" A decayed kinsman bowed himself to the
 ground.

" ——— The Lady Bauffiere rode on.

" He ran begging bare-headed on one side of her
 " palfrey, conjuring her by the former bonds of
 " friendship, alliance, consanguinity, &c.—cousin,
 " aunt, sister, mother—for virtue's sake, for your
 " own,

“ own, for mine, for Christ’s sake, remember me—
“ pity me.

“ ——— The Lady Bauffiere rode on.”*

The citation of the original passage from Burton will confirm all I have said of his stile.

“ A poor decay’d kinsman of his sets upon him by the
“ way in all his jollity, and runs begging bare-headed by
“ him, conjuring him by those former bonds of friendship,
“ alliance, consanguinity, &c. uncle, cousin, brother,
“ father, — — — Shew some pity for Christ’s sake, pity a
“ sick man, an old man, &c. he cares not, ride on:
“ pretend sickness, inevitable loss of limbs, plead suretyship,
“ or shipwreck, fires, common calamities, shew thy wants
“ and imperfections, — — — swear, protest, take God and
“ all his angels to witness, quære peregrinum, thou art a
“ counterfeit crank, a cheater, he is not touched with it,
“ pauper ubique jacet, ride on, he takes no notice of it.
“ Put up a supplication to him in the name of a thousand
“ orphans, an hospital, a spittle, a prison as he goes by,
“ they cry out to him for aid: ride on — — — Shew
“ him a decay’d haven, a bridge, a school, a fortification,
“ &c. or some public work; ride on. Good your worship,
“ your honour, for God’s sake, your Country’s sake:
“ ride on.”†

This curious Copy is followed up, in Tristram Shandy, by a Chapter, and that a long one, written almost

* Tristram Shandy, Vol. v. Chap. 1.

† Anat. of Melanch. p. 269.

almost entirely from Burton. It is the Consolation of Mr. Shandy, on the death of Brother Bobby.

“ When Agrippina was told of her son’s death, Tacitus informs us, that, not being able to moderate the violence of her passions, she abruptly broke off her work.” This quotation did not come to Sterne from Tacitus. *“ Mezentius would not live after his son - - - And Pompey’s wife cry’d out at the news of her husband’s death, Turpe mori post te, &c.—as Tacitus of Agrippina, not able to moderate her passions: So when she heard her Son was slain, she abruptly broke off her work, changed countenance and colour, tore her hair, and fell a roaring downright.”**

“ ’Tis either Plato,” says Sterne,” or Plutarch, or Seneca, or Xenophon, or Epictetus, or Theophrastus, or Lucian—or some one, perhaps of later date—either Cardan, or Budæus, or Petrarch, or Stella—or possibly it may be some divine or father of the Church, St. Austin, or St. Cyprian, or Bernard, who affirms, that it is an irresistible and natural passion, to weep for the loss of our friends or children—and Seneca, (I’m positive) tells us somewhere, that such griefs evacuate themselves best by that particular channel. And accordingly, we find that David wept for his son Absalom—Adrian for his Antinous†—
“ Niobe

* Anat. of Melanch. p. 213.

† The time has been, when this conjunction with the King of Israel would have smelt a little of the faggot.

“ Niobe for her children—and that Apollodorus
 “ and Crito both shed tears for Socrates before his
 “ death.” — This is well rallied, as the following
 passage will evince; but Sterne should have con-
 sidered how much he owed to poor old Burton.

“ *Death and departure of friends are things generally grie-*
 “ *vous; Omnium quæ in vita humana contingunt, luctus*
 “ *atque mors sunt acerbissima, [Cardan. de Consol.*
 “ *lib. 2.] the most austere and bitter accidents that can*
 “ *happen to a man in this life, in æternum valedicere, to*
 “ *part for ever, to forsake the world and all our friends,*
 “ *'tis ultimum terribilium, the last and the greatest terrour,*
 “ *most irksome and troublesome unto us, &c.—Nay many*
 “ *generous spirits, and grave staid men otherwise, are so*
 “ *tender in this, that at the loss of a dear friend they will*
 “ *cry out, roar, and tear their hair, lamenting some*
 “ *months after, howling O hone, as those Irish women,*
 “ *and Greeks at their Graves, commit many indecent*
 “ *actions,*” &c.* All this is corroborated by quo-
 tations from Ortelius, Catullus, Virgil, Lucan and
 Tacitus. I take them in the order assigned them
 by Burton. For he says with great probability of
 himself, that he commonly wrote as fast as possible,
 and poured out his quotations just as they happened
 to occur to his memory. But to proceed with Mr.
 Shandy's Consolation.

“ 'Tis

* Anat. of Melanch. p. 213.

“ 'Tis an inevitable chance—the first statute in
 “ Magna Charta—it is an everlasting act of Par-
 “ liament, my dear brother—all must die.”*

“ *'Tis an inevitable chance, the first statute in Magna
 “ Charta, an everlasting act of Parliament, all must
 “ die.*†

“ When Tully was bereft of his dear daughter
 “ Tullia, at first he laid it to his heart—he listened
 “ to the voice of Nature, and modulated his own
 “ unto it, &c.—But as soon as he began to look
 “ into the stores of Philosophy, and consider how
 “ many excellent things might be said upon the
 “ occasion—nobody upon earth can conceive, says
 “ the great orator, how joyful, how happy it made
 “ me.”||

“ *Tully was much grieved for his daughter Tulliola's
 “ death at first, until such time that he had confirmed his
 “ mind with some philosophical precepts, then he began to
 “ triumph over fortune and grief, and for her reception into
 “ heaven to be much more joyed than before he was troubled
 “ for her loss.*‡

Sterne is uncharitable here to poor Cicero.—

“ Kingdoms and provinces, and towns and cities,
 “ have they not their periods?” Where is Troy,
 and

* Tristram Shandy, Vol 5th. Chap. 3.

† Anat. of Melancholy, p. 215.

|| Sterne.

‡ Burton.

“ and Mycene, and Thebes, and Delos, and Persepolis, and Agrigentum. - - - - What is become, brother Toby, of Nineveh, and Babylon, of Cyzicum and Mytilene; the fairest towns that ever the sun rose upon, are now no more.”*

“ *Kingdoms, Provinces, Towns and Cities,*” says Burton, “ *have their periods, and are consumed. In those flourishing times of Troy, Mycene was the fairest city in Greece, - - - but it, alas, and that Assyrian Ninive are quite overthrown. The like fate hath that Egyptian and Bæotian Thebes, Delos, the common Council-house of Greece, and Babylon, the greatest City that ever the Sun shone on, hath now nothing but walls and rubbish left.*” - - - - *And where is Troy itself now, Persepolis, Carthage, Cizicum, Sparta, Argos, and all those Grecian Cities?*

Syracuse and Agrigentum, the fairest towns in Sicily, which had sometimes seven hundred thousand inhabitants, are now decayed. Let us follow Sterne again. “ turning out of Asia, when I sailed from Ægina towards Megara, I began to view the Country round about. Ægina was behind me, Megara was before, Pyræus on the right hand, Corinth on the left. What flourishing towns now prostrate on the earth! Alas! alas! said I to myself, that a man should disturb his soul for the loss of a Child, when so much as this lies awfully buried in his presence. Remember, said I to myself again—remember that thou art a Man.”

I

This

* Sterne.

This is, with some slight variations, Burton's translation of Servius's letter. Sterne alters just enough, to shew that he had not attended to the original. Burton's version follows.

" Returning out of Asia, when I sailed from Ægina toward Megara, I began to view the Country round about. Ægina was behind me, Megara before, Pyræus on the right hand, Corinth on the left; what flourishing towns heretofore, now prostrate and overwhelmed before mine eyes? Alas, why are we men so much disquieted with the departure of a friend, whose life is much shorter? When so many goodly Cities lie buried before us. Remember, O Servius, thou art a Man; and with that I was much confirm'd, and corrected myself."

" My Son is dead," says Mr. Shandy, " so much the better,* 'tis a shame, in such a tempest, to have but one Anchor."

I—but he was most dear and loving friend, quoth Burton, my sole friend—Thou maist be ashamed, I say with Seneca, to confess it, in such a tempest as this, to have but one anchor.

" But," continues Mr. Shandy, " he is gone for ever from us! be it so. He is got from under the hands of his barber before he was bald. He is but risen from a feast before he was surfeited—from a banquet before he had got drunken. The Thracians wept when a child was born, and feasted and made merry when a man went
" out

* This is an awkward member of the sentence.

“ out of the world, and with reason. Is it not
 “ better not to hunger at all, than to eat? not to
 “ thirst, than to take physic to cure it? Is it not
 “ better to be freed from cares and agues, love and
 “ melancholy, and the other hot and cold fits of
 “ life,† than, like a galled traveller, who comes
 “ weary to his inn, to be bound to begin his journey
 “ afresh?”

I shall follow Burton's collections as they stand in his own order.‡ “ *Thou dost him great injury to desire his longer life. Wilt thou have him crazed and sickly still, like a tired traveller that comes weary to his Inn, begin his journey afresh? - - - he is now gone to eternity - - - - as if he had risen, saith Plutarch, from the midst of a feast, before he was drunk - - - Is it not much better not to hunger at all, than to eat: not to thirst, than to drink to satisfy thirst; not to be cold, than to put on clothes to drive away cold? You had more need rejoice that I am freed from diseases, agues, &c. The Thracians wept still when a child was born, feasted and made mirth when any man was buried: and so should we rather be glad for such as die well, that they are so happily freed from the miseries of this life.*||

I 2

Again—

† This approaches to one of Shakespeare's happy expressions:

Duncan is in his grave:

After *Life's fitful fever*, he sleeps well.

‡ Sterne has commonly reversed the arrangement, which produces a strong effect in the comparison.

|| Anat. of Mel. p. 216.

Again—"Consider, brother Toby,—when we are, death is not, and when death is, we are not"—So Burton translates a passage in Seneca: *When we are, death is not; but when death is, then we are not.** The original words are, *quum nos sumus; mors non adest; cum vero mors adest, tum nos non sumus.*

"For this reason, continued my father, 'tis
 "worthy to recollect, how little alteration in great
 "men the approaches of death have made. Vespasian died in a jest ----- Galba with a
 "sentence—Septimius Severus in a dispatch; Tiberius in dissimulation, and Cæsar Augustus in a
 "compliment." This conclusion of so remarkable a Chapter is copied, omitting some quotations, almost verbatim, from Lord Verulam's Essay on Death.

We must have recourse to Burton again, for part of the Tristia-Pædia. "O blessed health! cried
 "my father, making an exclamation, as he turned
 "over the leaves to the next Chapter,—thou art
 "above all gold and treasure; 'tis thou who enlargest the soul,—and openest all its powers to
 "receive instruction, and to relish virtue.—He
 "that has thee, has little more to wish for;—and
 "he that is so wretched as to want thee,—wants
 "every thing with thee.†

*O blessed health! says Burton, thou art above all gold
 and*

* P. 213.

† Chap. 33, vol. 5.

and treasure; [Ecclesiast.] the poor man's riches, the rich man's blifs, without thee there can be no happiness.*

*O beata sanitas, te presente, amœnum
Ver floret gratiis, absque te nemo beatus.*

But I should, in order, have noticed first an exclamation at the end of Chapter ix. in the spirit of which no body could expect Sterne to be original. "Now I love you for this—and 'tis this
" delicious mixture within you, which makes you
" dear Creatures what you are—and he who hates
" you for it—all I can say of the matter is, That
" he has a pumpkin for his head, or a pippin for
" his heart,—and whenever he is dissected 'twill be
" found so."—Burton's Quotation is: *Qui vim non
sensit amoris, aut lapis est, aut bellua*: which he translates thus: *He is not a man, a block, a very stone, aut
Numen, aut Nebuchadnezzar, he hath a gourd for his head,
a pippin for his heart, that hath not felt the power of it.*

In Chap 36, vol. vi. Sterne has picked out a few quotations from Burton's Essay on Love-Melancholy,† which afford nothing very remarkable except Sterne's boldness in quoting quotations.

By help of another extract‡ from Burton, Sterne makes a great figure as a curious Reader: "I hate
" to make mysteries of nothing;—'tis the cold
" cautiousness

* Page 104. *ibid.* Page 276.

† See Burton, page 310, & seq.

‡ Trist. Shandy, vol. vii. c. 12.

"cautiousness of one of those little souls from
 "which Lessius (lib. 13. de moribus divinis, ch.
 "24.) has made his estimate, wherein he setteth
 "forth, That one Dutch mile, cubically multi-
 "plied, will allow room enough, and to spare,
 "for eight hundred thousand millions, which he
 "supposes to be as great a number of souls (count-
 "ing from the fall of Adam) as can possibly be
 "damn'd to the end of the world. - - - I am
 "much more at a loss to know what could be
 "in Franciscus Ribera's head, who pretends that
 "no less a space than one of two hundred
 "Italian miles, multiplied into itself, will be suffi-
 "cient to hold the like number—he certainly must
 "have gone upon some of the old Roman souls,"
 &c.

The succeeding raillery is very well, but unfair
 with respect to the mathematical Theologist, as the
 original passage will prove. "*Franciscus Ribera, in*
cap. 14. Apocalypf. will have Hell a material and local
fire in the centre of the earth, 200 Italian miles in diameter;
as he defines it out of those words, Exivit sanguis de
terra—per Stadia mille sexcenta, &c. But Lessius, lib.
13. de moribus divinis, cap. 24. will have this local hell
far less, one Dutch mile in diameter, all filled with fire and
brimstone; because, as he there demonstrates, that space
cubically multiplied will make a sphere able to hold eight hundred
thousand millions of damned bodies, (allowing each body six
foot square) which will abundantly suffice." [I believe
 the damn'd, upon Lessius's scheme, would be less
 crouded

crouded, than the victims of the African Slave-trade have often been, on the middle passage.] “*Cum certum sit, inquit, facta subductione, non futuros centies mille millones damnandorum.**

Again, at the end of the same Chapter in Tristram Shandy; “but where am I? and into what a “delicious riot of things am I rushing? I—I who “must be cut short in the midst of my days,” &c. Burton concludes his Chapter “on Maids’, Nunns’, “and Widows’ Melancholy,” in the same manner. “*But where am I? into what subject have I rushed? What have I to do?*”† &c.

I shall just observe by the way, that a pretty passage in the *Story of the King of Bohemia and his seven castles*; — “MODESTY scarce touches with a “finger what LIBERALITY offers her with both hands “open”—alludes to a picture of Guido’s, the design of which it describes tolerably well.

Retournons a nos moutons, as Rabelais would say; in matters of painting, it is dangerous for a man to trust his own eyes, till he has taken his degree of Connoisseur.

It confirms me strongly in the belief that the character of Mr. Shandy is a personification of the authorship of Burton, when I find such a passage as the following in Sterne. “There is a Philippic in “verse on somebody’s eye or other, that for two
“ or

* Anat. of Melanch. p. 156.

† Page 124.

“ or three nights together had put him by his rest :
 “ which, in his first transport of resentment against
 “ it, he begins thus :

“ A Devil 'tis—and mischief such doth work,
 “ As never yet did Pagan, Jew, or Turk.”

This choice couplet is quoted by Burton* from some bad Poet, now unknown, of whose name he only gives the initials.

“ Hilarion the hermit, in speaking of his abstinence, his watchings, flagellations, and other instrumental parts of his religion,—would say—
 “ tho' with more facetiousness than became an hermit—That they were the means he used, to
 “ make his afs (meaning his body) leave off kicking.”†

“ By this means Hilarion made his Afs, as he call'd his own body, leave kicking (so Hierome relates of him in his life) when the Devil tempted him to any foul offence.”‡

“ I wish, Yorick, said my father, you had read
 “ Plato; for there you would have learnt that there
 “ are two Loves— --- of these Loves, according
 “ to Ficinus's comment upon Velasius, the one is
 “ rational—the other is natural—the first ancient—
 “ without

* Page 331.

† Tr. Shandy, vol. viii. chap. 31.

‡ Burton, p. 333.

“ without mother—where Venus has nothing to
 “ do: the second, begotten of Jupiter and
 “ Dione—”*

† *One Venus is ancient, without a Mother, and descended from Heaven, whom we call celestial. The younger begotten of Jupiter and Dione, whom commonly we call Venus. Ficinus, in his comment upon this place, cap 8. following Plato, called these two loves, two Devils, or good and bad Angels according to us, which are still hovering about our souls ‡*

That part of the letter to Uncle Toby, which consists of obsolete medical practices, is taken from one of the Chapters on the Cure of Love-Melancholy. || Many curious quotations might be added to what Sterne knew, out of Dr. Ferrand's *Eräto-*mania; but this Essay is already long enough.

There is another writer, whose pathetic manner Sterne seems to have caught; it is Marivaux,—the father of the sentimental style. A careful perusal of his writings, and of those of the younger Crebillon, might perhaps elucidate the serious parts of *Tristram Shandy*, and the *Sentimental Journey*. But I must leave this undertaking to those who have sufficient time to sacrifice to the task. From these

K Authors,

* *Tr. Shandy*, vol. viii. chap. 33.

† *Velasius* is quoted thro' all the preceding passages in *Burton*.

‡ *P.* 260.

|| *P.* 333 to 335.

Authors, I think, Sterne learnt to practice what Quintilian had made a precept: *Minus est totum dicere quam omnia*. With genius enough for the attempt, one has frequently failed in producing pleasure by the length of his digressions, and the other by affecting an excessive refinement and ambiguity in his language. *Les bons écrivains du siècle de Louis XIV. says Voltaire, ont eu de la force, aujourd'hui on cherche de Contorsions*. Our own writers are not free from this error; and it would not be unworthy their consideration, that a sentence, which is so much refined as to admit of several different senses, may perhaps have no direct claim to any sense.* Sterne has seldom indulged these lapses, for which he was probably indebted to the buoyant force of Burton's firm Old-English sinews.

Whoever will take the trouble of comparing Sterne's Dialogue with his own feelings, in the
Sentimental

* Maynard puts this very well:

Mon ami, chaffe bien loin
Cette noire Rhétorique,
Tes ouvrages ont besoin
D'un devin qui les explique.
Si ton esprit veut cacher
Les belles choses qu'il pense,
Di-moi, qui peut t'empêcher
De te servir du silence?

Sentimental Journey,† to that of Jacob with his Avarice and his Honour, in the first part of the Payfan Parvenu, will perceive a near resemblance. It would be cruel to insert the French declamation. A shorter passage from the same work will shew that the Shandean manner is very similar to that of Marivaux.

Le Directeur avoit laissé parler l'ainée sans l'interrompre, & sembloit même un peu piqué de l'obstination de l'autre.

Prenant pourtant un air tranquille et benin : ma chere Demoiselle, écoutez moi, dit il à cette cadette ; vous savez avec quelle affection particulière je vous donne mes conseils à toutes deux.

Ces derniers paroles, à toutes deux, furent partagées, de façon que la Cadette en avoit pour le moins les trois quarts & demi pour elle, et ce ne fut même que par reflexion subite, qu'il en donna le reste à l'ainée.‡

The curious hypothesis respecting Christian names, contains a just satire on what was once a popular superstition, and even cherished by the learned.

K 2

Pasquier,

† Compare also the first Conversation with Me. Freval, in the Payfan Parvenu, with a scene in the Sentimental Journey. Wherever Sterne picked up his Fragment, as he calls it, in the Sentimental Journey, on the power of Love, it is evidently ill-copied from the exordium of Lucian's admirable essay on the method of writing History.

‡ Payfan Parvenu, Partie, 2me.

Pasquier, in his *Recherches*, has a Chapter on the fortune of some Christian Names. In the present state of knowledge, it would be unpardonable to omit a remark, with which an author like Sterne would make himself very merry. It relates to the passage, in which Mr. Shandy treats the name of TRISTRAM with such indignity, and demands of his supposed Adversary, "Whether he had ever remembered,—whether he had ever read,—or whether he had ever heard tell of a man, call'd Triftram, performing any thing great or worth recording?—No,—he would say,—TRISTRAM!—The thing is impossible!" A Student of the fashionable black-letter erudition would have triumphed in proclaiming the redoubted Sir Triftram, Knight of the Round-table, and one of the most famous knights-errant upon record. Sterne might have replied:

Non scribit, cujus Carmina nemo legit ;*

and indeed his pleasant hero has no resemblance to the *preux Chevalier*.

I am sorry to deprive Sterne of the following pretty figure, but justice must be done to every one.

" In short, my father - - - - - advanced so very
 " slowly with his work, and I began to live and
 " get forward at such a rate; that if an event had
 " not

* Martial, Lib. 5.

“ not happened -- &c. I verily believe I had
 “ put by my father, and left him drawing a sun-
 “ dial, for no better purpose than to be buried
 “ under ground.”*

Donne concludes his poem entitled *The Will*,
 with this very thought:

And all your Graces no more use shall have
 Than a Sun-dial in a Grave.

There is a strange coincidence between Sterne
 and a mystic writer, in the insertion of a black page
 in each of their works. I cannot consider it as an
 imitation; for it must appear by this time, that
 Sterne possessed no great store of curious reading.

Every one knows the black pages in *Tristram
 Shandy*; that of prior date is to be found in Dr.
 Fludd's *Utriusque cosmi Historia*,† and is emblematic
 of the Chaos. Fludd was a man of extensive eru-
 dition, and considerable observation, but his fancy,
 naturally vigorous, was fermented and depraved,
 by astrological and Cabbalistic researches. It will
 afford a proof of his strange fancies, and at the same
 time do away all suspicion of Sterne in this instance,
 to quote the ludicrous coincidence mentioned by
 Morhoff, between himself and this Author. “ Co-
 gitandi modum in nobis et speculationes illas
 rationum, mirificè quodam in loco, videlicet in
 libro

* *Tr. Shandy*, vol v. chap. 16.

† Page 26.

libro *de mystica cerebri anatome* [Fluddius] ob oculos ponit. Solent ab anatomicis illic delineari genitalia membra, utriusque sexus, quod processus quidam et sinus, eum in modum figurati sunt. Hic Fluddius invenit, non quod pueri in faba, illic dicit generari c gitatione ; quod mihi mirum visum est, cum ego aliqua do joculari carmen *de Ente rationis* scriberem, et, ferente ita genio carminis, joci gratia finxisssem, illic generari Entia rationis, postea cum incidi in istud Fluddii, quod ne somniando quidem cogita eram, invenisse me, serio hæc asseri a Fluddio.*

I am not acquainted with the foundation of the curious passages respecting the possibility of baptizing infants *in utero*,† but I find that Mauriceau adverts to the circumstance, in his attack on the Cæsarian operation: “ il n’y a pas d’occasions ou
 “ on ne puisse bien donner le Baptême à l’enfant,
 “ durant qu’il est encore au ventre de la mere,
 “ étant facile de porter de l’eau nette par le moyen
 “ du Canon d’une seringue jusques sur quelque
 “ partie de son Corps”—He then obviates a difficulty unthought of by Sterne’s Doctors ; which persuades me that this passage of Mauriceau had not occurred to him—“ et il seroit inutile d’alleguer que l’eau
 “ n’y peut pas etre conduite, à cause que l’enfant
 “ est envelopé de ses membranes, qui en empêchent ;
 “ car

* Morhoff. Polyhist. Philos. lib. ii. p. 1. cap. 15.

† Tristram Shandy, vol. i. chap. xx.

“ car ne fçait-onpas qu'on les peut rompre tres
 “ aifément, en cas qu'elles ne le fuſſent pas, apres
 “ quo on peut toucher effectivement ſon Corps.”*

This writer has alſo mentioned the miſchievous effect of ſtrong preſſure applied to the heads of very young Children; which is connected with another theory that Sterne has diverted himſelf with. I have not met with the original of it in my reading, but will give a paſſage from Bulwer's *Anthropometamorphoſis*, analogous to Mauriceau's. †

The North-weſt paſſage to Learning, obſcurely mentioned in the *Triſtra-Pædia*, is deſcribed by Dr. Warton, in his excellent obſervations on the Genius and Writings of Pope, and was well burleſqued by Swift, in the *Voyage to Laputa*.‡

The

*Mauric. *Maladies des Femmes Groſſes*, p. 347 (edit. 3me. 4to. 1681.)

† I knew a Gentleman who had divers ſons, and the Midwives and Nurſes had with headbands and ſtrokings ſo alter'd the natural mould of their heads, that they proved children of a very weak underſtanding. His laſt ſon only, upon advice given him, had no reſtraint impoſed upon the natural growth of his head, but was left free from the coercive power of headbands and other artificial violence, whoſe head, although it were bigger, yet he had more wit and underſtanding than them all.

Artificial Changeling, p. 42.

‡ See the *Description and Print of the literary turning Machine*.

The best Commentary on Chap. 5, vol. 8th. is Montagne's essay on the subject.

There is one passage in the 7th. volume, which the circumstances of Sterne's death render pathetic. A believer in the doctrine of Pre-sentiment would think it a prop to his theory. It is as striking as Swift's Digression on Madness, in the Tale of a Tub.

" Was I in a condition to stipulate with Death
 " ---- I should certainly declare against submitting
 " to it before my friends; and therefore I never
 " seriously think upon the mode and manner of
 " this great catastrophe, which generally takes up
 " and torments my thoughts as much as the catastrophe itself, but I constantly draw the curtain
 " across it with this wish, that the Disposer of all
 " things may so order it, that it happen not to
 " me in my own house—but rather in some decent
 " inn----- in an inn, the few cold offices I
 " wanted, would be purchased with a few guineas,
 " and paid me with an undisturbed but punctual
 " attention." It is known that Sterne died in hired lodgings, and I have been told, that his attendants robbed him even of his gold sleeve-buttons, while he was expiring.

I have seen, not very long ago, a charge of plagiarism brought against Sterne, respecting his Sermons.

From what Author the passages were said to be borrowed, I do not remember; but it has long been
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my opinion, that the manner, the style, and the selection of subjects for those Sermons, were derived from the excellent *Contemplations* of Bishop Hall. There is a delicacy of thought, and tenderness of expression in the good Bishop's compositions, from the transfusion of which Sterne looked for immortality.

Let us compare that singular Sermon, entitled *THE LEVITE AND HIS CONCUBINE*, with part of the Bishop's *Contemplation of the LEVITE'S CONCUBINE*. I shall follow Sterne's order.

" — Then shame and grief go with her, and
" wherever she seeks a shelter, may the hand of
" justice shut the door against her."*

*What husband would not have said—She is gone, let
shame and grief go with her; I shall find one no less pleas-
sing, and more faithful.†*

" Our annotators tell us, that in Jewish æcono-
" micks, these (concubines) differed little from
" the wife, except in some outward ceremonies and
" stipulations, but agreed with her in all the true
" essences of marriage."‡

*The Law of God, says the Bishop, allowed the
Levite a wife; human connivance a concubine; neither did
the Jewish concubine differ from a wife, but in some out-
ward compliments; both might challenge all the true essence
of marriage.*

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* Sterne, Sermon xviii.

† Bp. Hall's Works, p. 1017.

‡ Sterne loc. citat.

I shall omit the greater part of the Levite's soliloquy, in Sterne, and only take the last sentences.

"Mercy well becomes the heart of all thy
"creatures, but most of thy servant, a Levite,
"who offers up so many daily sacrifices to thee,
"for the transgressions of thy people."

— "But to little purpose," he would add, "have
"I served at thy altar, where my business was to
"sue for mercy, had I not learn'd to practise it."

Mercy, says Bp. Hall, becomes well the heart of any man, but most of a Levite. He that had helped to offer so many sacrifices to God for the multitude of every Israelite's sins, saw how proportionable it was, that man should not hold one sin unpardonable. He had served at the altar to no purpose, if he (whose trade was to sue for mercy) had not at all learned to practise it.

It were needless to pursue the parallel.

Sterne's twelfth Sermon, on the Forgiveness of Injuries, is merely a dilated Commentary on the beautiful conclusion of the *Contemplation* 'of Joseph.'

The sixteenth Sermon contains a more striking imitation. "There is no small degree of malicious
"craft in fixing upon a Season to give a mark of
"enmity and ill-will;—a word, a look, which,
"at one time, would make no impression,—at
"another time, wounds the heart; and, like a
"shaft flying with the wind, pierces deep, which,
"with its own natural force, would scarce have reached
"the object aimed at."

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This is little varied from the original: *There is no small cruelty in the picking out of a time for mischief; that word would scarce gall at one season, which at another killeth. The same shaft flying with the wind pierces deep, which against it, can hardly find strength to stick upright.**

In Sterne's fifth Sermon, the *Contemplation of Elijah with the Sareptan*, is closely followed. Witness this passage out of others: "The Prophet
" follows the call of his God:—the same hand
" which brought him to the gate of the city, had
" led also the poor widow out of her doors, oppressed with sorrow."†

The Prophet follows the call of his God; the same hand that brought him to the gate of Sarepta, led also this poor widow out of her doors.‡

The succeeding passages which correspond are too long for insertion.

Sterne has acknowledged his acquaintance with this book, by the dissimilarity of two ludicrous quotations in *Tristram Shandy*.||

What assistance the writings of Voltaire and Rousseau afforded Sterne, I omit to enquire. The former was the first author of this age, who introduced the terms and operations of the modern art of war into works of entertainment; but Sterne's military ardour seems to have been inspired by the prolix details of honest Tindal. Voltaire himself reviewed the first volumes of *Tristram*

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Shandy,

* Hall's *Shimei Cursing*. † Sterne.

‡ Bp. Hall, P. 1323. || Vol. 1. Chap. 22. and Vol. 7. Chap. 13

Shandy, in one of the foreign Journals, and did not charge their author with the imitation of any persons but Rabelais and Swift. He was probably not very jealous of the reputation of a modern English writer.

Such are the casual notes, with the collection of which I have sometimes diverted a vacant half-hour. They leave Sterne in possession of every praise but that of curious erudition, to which he had no great pretence, and of unparelled originality, which ignorance only can ascribe to any polished writer. It would be enjoining an impossible task, to exact much knowledge on subjects frequently treated, and yet to prohibit the use of thoughts and expressions rendered familiar by study, merely because they had been occupied by former Authors. There is a kind of imitation which the Ancients encouraged, and which even our Gothic Criticism admits, when acknowledged. But justice cannot permit the Polygraphic Copy to be celebrated at the expence of the Original.

Voltaire has compared the merits of Rabelais and Sterne, as Satirists of the Abuse of Learning, and, I think, has done neither of them justice. This great distinction is obvious; that Rabelais derided absurdities then existing in full force, and intermingled much sterling sense with the grossest parts of his book; Sterne, on the contrary, laughs at many exploded opinions, and abandoned fooleries, and contrives to degrade some of his most
solemn

solemn passages by a vicious levity. Rabelais flew a higher pitch, too, than Sterne. Great part of the voyage to the *Pays de Lanternois*,* which so severely stigmatizes the vices of the Romish Clergy of that age, was performed in more hazard of fire than water.

The follies of the Learned may as justly be corrected, as the vices of Hypocrites; but for the former Ridicule is a sufficient punishment. Ridicule is even more effectual to this purpose, as well as more agreeable than scurrility, which is generally preferred, notwithstanding, by the learned themselves in their contests, because Anger seizes the readiest weapons;

Jamque faces et saxa volant; furor arma ministrat:

And where a little extraordinary Power has accidentally been lodged in the hands of disputants, they have not scrupled to employ the most cogent methods of convincing their adversaries. Dionysius the Younger sent those Critics who disliked his verses, to work in the Quarries;† and there was a pleasant Tyrant, mentioned by Horace, who obliged his deficient debtors to hear him read his own Compositions, *amaras historias*, by way of commutation. I say nothing of the “ holy faith of pike and

* I do not recollect to have seen it observed by Rabelais's Commentators, that this name, as well as the plan of the Satire, is imitated from Lucian's *True History*. Lucian's town is called *Lychnopolis*.

† Plutarch.

and gun," nor of the strong cudgel with which Luther terminated a theological dispute, as I desire to avoid Religious Controversy. But it is impossible, on this subject, to forget the once celebrated Dempster, the last of the formidable sect of Hoplomachists, who fought every day, at his School in Paris, either with sword or fist, in defence of his doctrines in omni scibili.† The imprisonment of Galileo, and the example of Jordano Bruno, burnt alive for asserting the Plurality of Worlds,|| among other disgraceful instances, shew that Laughter is the best crisis of an ardent disputation.

The talents for so delicate an office as that of a literary Cenfor, are too great and numerous to be often assembled in one person. Rabelais wanted decency, Sterne learning, and Voltaire fidelity. Lucian alone supported the character properly, in those pieces which appear to be justly ascribed to him. As the narrowness of Party yet infests Philosophy, a writer with his qualifications would still do good service in the Cause of Truth. For wit and good sense united, as in him they eminently were, can attack nothing successfully which ought not to be demolished.

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† Jan. Nic. Erythræ. Pinacothie:

|| .Brucker. Hist. Critic. Philosoph. Tom. v. P. 28, 29.

The famous Scioppius published a shocking letter of exultation on this execution.

An Account of, and Observations on, different BLUE COLOURS, produced from the Mother Water of Soda Phosphorata, &c. by Mr. THOMAS WILLIS, of LONDON. — Communicated by THOMAS HENRY, F. R. S. &c.

To Mr. THOMAS HENRY.

SIR,

I request the favour of you, to lay before the Society the inclosed Paper (containing an Account of, and Observations on different blue Colours, produced from the Mother-waters of Soda Phosphorata) for their inspection, and shall be much honoured if it should merit their approbation.

The colour No. 1, seems to be a sort of Prussian blue, but is much closer in its texture, and on breaking it, appears somewhat glossy.

As three of these colours are in the hands of different Painters, should they prove useful, I shall take the earliest opportunity of communicating the intelligence to the Society.

I am, Sir,

Your most obliged and obedt. servant,

April 12, 1791.

THO^s. WILLIS.

AN ACCOUNT, &c.

ACCIDENT led to the discovery of these Colours, which it is to be hoped will be found useful in the art of painting. Two of them have something of the appearance of Prussian blue, but from the following investigations there seems to be some other principle besides Phlogisticated Alkali for their basis; which I must confess I am not able to account for, but leave it to the judgment of Gentlemen of greater abilities than I can pretend to.

After I had extracted all the Chrystals of Soda Phosphorata from a combination of the Phosphoric Acid with pure mineral Alkali, or with the best Spanish Barilla freed from as much common salt as possible, I generally threw away the Mother-water as useless, which being poured through an iron grating, some of it was scattered about, and appeared of a blueish colour on the contiguous stones: upon which appearance, imagining it to proceed from a Phlogisticated Alkali, I dissolved four ounces of common alum and one ounce of martial vitriol in two quarts of water, by boiling them together. On some of the Mother-water of Soda Phosphorata was poured a little of the aluminous and martial solution: at first a greyish coagulum only was formed;

formed; but upon adding more of the solution, a fine blue colour was produced which readily precipitated. This being washed frequently with water till the supernatant liquor was quite tasteless, was then dried, and produced the colour No. 1.

As I was desirous of seeing whether Roch Alum would have any different effect, four ounces of Roch Alum and one ounce of Martial Vitriol were dissolved in two quarts of water, by boiling them together, and with some of this solution a precipitate from the Mother-water of Soda Phosphorata was produced, which, after it was well washed, yielded the blue Colour No. 2, which is of a very pale hue.

A small quantity of these powders was given to a person that paints in water colours, who on trying them said they were too spongy for that purpose.

As there was a very copious, light precipitate produced in the above two experiments, and the colouring matter, when dried, but small in quantity; I evaporated the Mother-water of Soda Phosphorata to a thick pellicle, and a deliquescent salt was produced: the remaining liquor was precipitated with a solution of common Alum and Martial Vitriol, made with the proportions above-mentioned. A precipitate, not so light as the two others, and in appearance less in quantity, was produced, but which, when washed and dried, yielded about the same weight as the others. It was of a paler blue than the first production, but of a bright colour; some of which is contained in the paper marked No. 1, with a +.

This has not yet been tried as a water colour, nor have I received any account of their being useful oil-colours, although I have given some of each of them to different Painters, as also a portion of some of the next preparation.

Thinking that the Aluminous Earth was the reason of the sponginess of the colours, when used as water colours, I thought, by precipitating the Mother-water of Soda Phosphorata with a martial solution alone, it might produce a colour free from that sponginess complained of; therefore I added to the Mother-water above-mentioned, a saturated solution of Martial Vitriol, and a very copious precipitate was formed, but of a less beautiful colour than either the first or third. The precipitate was very light, and required some length of time to settle: it was washed till perfectly tasteless, and although it occupied much space, being so very expansive, it yielded a less proportion of dry colour than either of the former processes, and was not so deep a blue as No. 1.

As this last colour, when dried, had a little brownish tinge on its surface, I concluded it proceeded from its having some ochry matter mixed with it; to free it from which, I added a little Oil of Vitriol to a small portion of it, and the whole became of a dirty green, which, on being poured into water, turned of a deep blue. This was well washed to free it from all acidity; but the colour did not appear to be improved.

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In order to examine whence this colouring matter proceeded, the following experiments were made :

1st. Some pure Soda Phosphorata was dissolved, to which was added a portion of the aluminous and martial solution. A dirty white coagulum was formed, which, by adding more of the precipitating liquor, was redissolved entirely.

2d. To some of the same solution of Soda Phosphorata was added a solution of Martial Vitriol: a similar coloured coagulum appeared, of which, upon furcharging it with the latter solution, the greatest part was redissolved, and the remainder continued unchanged in colour.

3d. With Sal Soda dissolved in water, the aluminous and martial solution precipitated a dirty white colour, which being overcharged with the precipitating liquor, part was redissolved; but what remained was not altered in colour.

4th. Some of the same solution of Sal Soda was precipitated with a solution of vitriolated iron: a very large quantity of brown precipitate was produced, which being overcharged with the solution of iron, effervesced much, and the precipitate was redissolved.

This experiment was some time afterwards made with another solution of Sal Soda, and the solution of vitriolated iron: when a similar coloured precipitate was produced, but being overcharged with the latter, only part of the precipitate was redissolved, but there was no alteration of colour.

5th. The Mother-water of Sal Soda, precipitated with the aluminous and martial solution, gave at first a dirty brown colour, which did not dissolve, but upon supersaturation was changed to a pale blue colour: but this was only from one parcel of the Mother-water of Sal Soda; for on trying various other Mother-waters of Sal Soda, very different productions were obtained. From some a dirty brown, from others a dirty white, from others a grey. The best colour that was produced is the small quantity sent, marked No. 3. As the Barilla that is brought from Spain is very unequal in its strength and quantity, the difference of the precipitates is not much to be wondered at.

6th. With the same Mother-water as mentioned in the 5th. experiment, and a solution of martial vitriol, much the same effect was produced, only a less copious precipitate, and of a paler colour, but, in several other trials, on various other Mother-waters of Sal Soda, generally a brown coloured precipitate was produced.

7th. The pure Mineral Alkali from the East-Indies, dissolved in water, and precipitated with the Aluminous and Martial Solution, formed a dirty white precipitate, which being overcharged with the precipitating liquor, effervesced very much. Part of the precipitate was re-dissolved, and the remainder retained its colour.

8th. To the same Solution of Mineral Alkali mentioned in the 7th. Experiment, was added a Solution
of

of Vitriolated Iron. A large quantity of olive-green coagulum appeared. Upon supersaturating it, a great effervescence was excited and the whole of the coagulum was re-dissolved, yielding a brownish green, diaphanous liquor, but upon standing all night in the glass vessel, a brownish-green precipitate fell down.

9th. The Acid of Phosphorus was added to the Aluminous and Martial Solution, and it gave a pale white precipitate.

10th. The Acid of Phosphorus being added to the Solution of Vitriol of Iron, no decomposition took place.

It appears that from the Mother-water produced from the combination of the Phosphoric Acid and Mineral Alkali, a blue colour is *always* obtained by means of a martial Solution; and that from the Mother-water of Sal Soda it is uncertain, and what is produced is of a pale colour; and that this fact might be more satisfactorily ascertained, the Mother-waters of Sal Soda, that were used, were those from which the Salt had been extracted to make the Soda Phosphorata, whose Mother-waters were tried in these experiments.

It is true also that the Mother-water of tartarized Natron will sometimes yield a Prussian blue, but not always, and whenever it does, it is generally pale-coloured; but in all the experiments made with the Phosphorated Alkaline Mother-waters above related, a deep blue colour has been produced, except

except in the single one made with Rock Allum; for the other operations have been repeated, and the results have been uniform.

The Acid of Phosphorus has been tried with the two precipitating liquors, and no blue colour was produced. It therefore remains to account, how this blue colour should be continually produced by the combination above-mentioned, especially as the phosphoric Acid was obtained from bones burned to a perfect whiteness, which might be expected to destroy the tinging principle.

Some of the best Prussian blue that could be purchased, was added to the strong Vitriolic Acid. It was changed to a green colour, but much paler than that produced from the colour precipitated by the Martial Solution, as above related, by adding the Acid of Vitriol to it; but on diluting the Prussian blue, digested in the Vitriolic Acid, with water, a large quantity of white powder was perceived, which evidently must be the Earth of Alum. Upon further diluting and stirring the mixture, it readily mixed with the tinging matter, and appeared uniformly blended therewith.

A portion of the blue colour, No. 1. was likewise digested with strong Vitriolic Acid. It was changed to a darker green colour than in the last mentioned process, but on diluting it with water, it changed uniformly to blue: but on digesting some of No. 2 with the Vitriolic Acid, there was a separation when the mixture was diluted with
water;

water; at first the mixture was of a deeper green than that with the Prussian blue digested in Vitriolic Acid; and upon diluting it, at first the liquor altered but little; yet, in the space of half a minute it became of a deeper blue than the original, but a large quantity of a dirty white coloured matter was separated.

It also appears, that there is very little difference between the pure mineral Alkali brought from the East-Indies, and the best Spanish Barilla, when it is freed as much as possible from common Salt.

From the deep colouring matter separating on the dilution of Prussian blue, digested with Vitriolic Acid, by adding water to it, Quere, Whether a much finer blue might not be produced by pouring off that blue liquor from the white powder, and edulcorating it?

*On the Impression of Reality attending Dramatic Representations, by J. AIKIN, M. D.—
Communicated by DR. PERCIVAL.*

Read October 7.

DR. Johnson, in his Preface to Shakespear, excuses that great poet's violation of the *Dramatic Unities*, and argues against the law by which they have been enjoined, upon this principle—That as, in fact, we are never so deceived by a dramatic representation, as to believe it *real*, there is no danger of injuring its effect by any thing which may tend to destroy such a belief. And he seems to triumph not a little, in exposing the absurdity of an imagined conviction, that a scene passing before our eyes is *real*, when we are all the time conscious that it began in fiction.

But it appears to me, that in this instance (as perhaps in many others) the critic has taken a very narrow survey of the human mind, and has only skimmed the surface for that truth which lay somewhat deeper. The question respecting the nature of that feeling which a scene of fiction excites in us, must be determined by a reference to the general mode in which the mind receives impressions. Now, I shall attempt to shew, that although the

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the means by which emotions are raised are very various, yet that, when raised, they are all precisely the same in their nature, and only differ in degree of intensity. This, I think, will manifestly appear, if, in the first place, the same principle which is necessary to account for the effect of one of these means, will equally account for all; and, in the second place, if the evident and external expressions of our emotions are similar in every case.

Why is it that the view of a *real* scene of distress, in which we are not personally concerned, operates upon our feelings, but in consequence of that general principle of our nature, whereby the image of human passions in another, excites corresponding emotions in ourselves? *Reality* itself cannot operate upon us without a *medium*; and in what respect does the action produced by the direct medium of the senses, differ from that produced by the remoter mediums of recollection, narration, or any mode of fictitious representation? I behold a person suffering under the extremity of torture, and find myself highly affected at the spectacle. I make his feelings in some respect my own;—my flesh creeps upon my bones, and the pain of sympathy rises to such a degree as to become intolerable. It is now over, and that portion of human misery has no longer an existence. Still the scene recurs to my mind, and whenever it intrudes, all my pain is renewed, though with less intensity; and this continues to be the case till the ideas fade away. The

identity of the sensation is proved by the sameness of the corporeal effects. If I shuddered and turned pale at the real spectacle, I do the same at the first recollections: if I ran with horror from the former, I plunge into company or business to deliver me from the latter. Now, if it be allowed, that my own mind, acting upon itself, without the aid of external objects, be capable of creating an imaginary scene indistinguishable in its effects from a real one, why should not equal power be granted to those artificial methods, in which resembling, sensible objects are called in to assist the operations of the fancy?

But, it may be said, no one denies as a matter of fact, the power of recollection and fictitious representation to move the passions, and the question is only, what is necessary to the production of this effect? Now, since in the case of a recollected scene, it cannot be a *belief of reality*, (for no man *believes* that the event on which he reflects is acted over again) why should such *belief* have any thing more to do with the efficacy of fiction? And this reasoning (on which Dr. Johnson diffusely dwells) is just, as far as it goes; but his error consists in confounding with *proper belief*, that *impression of reality*, or *temporary illusion*, which I conceive absolutely essential to account for the undoubted effects produced by all the various *imitations of action*. *Belief* is the consequence of a reflex operation of the mind, by which we are convinced of a truth after examination or enquiry.

enquiry. It is therefore incompatible with the impressions of illusion; for, as soon as they are examined, they are at an end. We cannot ask ourselves whether they are true, without discovering them to be false. But it is certain we are often so impressed with a notion, as to entertain no present doubts about it, though it is no object of our *belief*, but, on the contrary, has repeatedly been detected by us as a falsehood.

Dr. Johnson himself, speaking of what he terms the *extrusion* of Gloucester's eyes in *Lear*, says, that it "seems an act too horrid to be endured in dramatic exhibition, and such as must always compel the mind to relieve its distress by incredulity." Does not this expressly imply, that a *less* horrid and unnatural action would pass on the stage for real; and that the usual affection of the mind in dramatic exhibitions is an impression of reality? *Historical incredulity* cannot be here meant; for how are we sure that the story was *not* true? besides, we read with tolerable tranquillity of facts still more shocking. It must then be the "*incredulus odi*" of Horace,—a resolution to discard and reject what so much pains us. Horace did not disbelieve that Medea had murdered her children; but when the fact was represented to him in a visible display, the horror he felt made him refuse to admit it as a true scene.

Further to elucidate this idea of the *impression of reality* as distinct from *belief*, let us trace the progress of the imagination from the instances in which it is
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least assisted by external objects, to those in which it is *most* so. And, not to dwell upon the conviction of reality attending dreams, delirium, and insanity, where there is probably a physical cause operating on the brain, I shall first consider the case of a reverie, or day-dream.

Sitting alone in my study, I shut my book, lean back in my chair, and following, either involuntarily or with design, a particular train of ideas, soon become insensible to all the objects around me, and with the mind's eye behold a course of action with its correspondent scenery, in which I appear engaged either as a spectator or an actor. The consciousness of my real condition is for a time suspended; and I feel pleasure or pain, approbation or disgust, according to the nature of the fancied scene. Nor are *actions* indicative of what passes within, entirely wanting; and though I may not, with the violence of Alonzo kicking the basket, spurn the table from me, yet I smile, frown, move my lips, and assume imperfect gestures and attitudes, in correspondence with my internal emotions. Here, then, is a perfect illusion effected by the mental faculties alone; commencing with complete consciousness of my real situation, and proceeding to as complete a forgetfulness of it. A person enters the room—and the pageant vanishes.

Again—I sit in the same place, and take up Sterne's story of Le Fevre. I am perfectly apprized, not only that Le Fevre is not in my room, but
that

that no such person ever existed. But as I read, I suffer the writer to lead me into the same kind of reverie which I had in the former instance created for myself; and I follow him with the greater ease, as my mind is not encumbered with the labour of invention, but passively admits those representations of action and discourse, which he has wrought into such an admirable resemblance of nature. I soon become so rivetted to the book, that external objects are obliterated to me. I pity, glow, admire; my eyes are suffused; I sob; I am even *audible* in my expressions of sympathy; till a message breaks the charm, and summons me away, full of shame at the real tokens remaining of emotions founded on fiction. Now will any-one, fairly consulting his feelings, assert that in such a case he weeps merely from the reflexion on possible human calamities; and that Le Fevre is not for the time a real person in his imagination?

Once more—I read in Tacitus the highly-wrought description given by that historian of the return of Agrippina to Italy, after the death of Germanicus. I feel myself much interested; but from the rapidity of the narration, the want of those minute strokes which are necessary to fill up the picture of real life, and the intermixture of the author's reflexions, the whole is rather addressed to the intellect than to the imagination; and I rather cry, “How admirably this is described!” than view a distinct spectacle passing before my sight. But in the midst
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of my reading, I chance to cast my eyes upon West's picture of Agrippina landing at Brundisium: I see her, with downcast eyes, pale and extenuated, embracing the funeral urn—her little children hanging at her garment;—I see the awe-struck crowd, the mourning lictors, and the hardy veterans bursting into tears. Now, indeed, the illusion is complete. I think no longer of Tacitus or West—my heart and my eyes obey without resistance every call to sympathize with the widowed Agrippina. Here, then, an external object, addressed to one of the senses, is called in to aid the creative power of the imagination.

Attend me next to the *theatre*. I go, it is acknowledged, with the full conviction that the place is Drury-lane, and that the actors are merely players, representing a fiction for their own emolument. Nay, I go with the avowed purpose of seeing a favourite actress in a particular character. The curtain draws up, and after some preparation, enters Mrs. Siddons in Belvidera. The first employment of my mind is to criticize her performance, and I admire the justness of her action, and the unequalled expressiveness of her tones and looks. The play proceeds, and I am made privy to a horrid plot. With this, domestic distresses are mingled, involving the two most interesting characters in the piece. By degrees, I lose sight of Mrs. Siddons in her proper person, and only view her in the assumed shape of Belvidera. I cease to criticize her,

her, but give way with full soul to all the sentiments of love, tenderness, and anxiety which she utters. As the catastrophe advances, the accumulated distress and anguish lay fast hold on my heart: I sob, weep, am almost choaked with the mixed emotions of pity, terror, and apprehension, and totally forget the theatre, the actors, and the audience, till, perhaps, my attention to present objects is recalled by the screams or swooning of a neighbour still more affected than myself. Shall the cold critic now tell me, I am sure you do not *believe* Mrs. Siddons to be Belvidera, and therefore you can only be affected in consequence of "the reflexion that the evils before you are evils to which yourself may be exposed—you rather lament the possibility, than suppose the presence, of misery." The identity of Belvidera is out of the question; for who was Belvidera? and certainly my own liability to evils, some of them impossible to happen to me, and others highly improbable, is the farthest thing from my thoughts; besides, were the effect of a spectacle of distress dependant on this principle, it would be equally requisite in the real, as in the fictitious scene. What I feel, is *genuine sympathy*, such as by a law of my nature ever results from the image of a suffering fellow-creature, by whatsoever means such an image is excited. The more powerfully it is impressed on my imagination, and the more completely it banishes all other ideas

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either of sense or reflexion, the more perfect is its effect; and reality has no advantage in this respect over fiction, as long as the temporary illusion produced by the latter continues. That such an *illusion* should take place at the theatre, where every circumstance art can invent has been employed to favour it, cannot be thought extraordinary, after it has been shewn, that a scene of the mind's own creation can effect it.

And for what end, but that of deception, are such pains taken in adjusting the scenery, dresses, decorations, &c. to as near a resemblance as possible of reality? — why might not the piece be as well read in the closet as represented on the stage, if all its effect depended on the pleasing modulation of language, prompting just reflections on life and manners? Some effect, doubtless, is produced by a tragedy *read*; but this is exactly in proportion to the dramatic powers of the reader, and the strength of imagination in the hearer; and always falls much short of that of a perfect representation on the stage.

But, says the critic, “the delight of tragedy proceeds from a consciousness of fiction; if we thought murders and treasons real, they would please no more.” *Delight* is not the word by which I would chuse to denote those sensations in the deeper scenes of tragedy, which often arise to such a pitch of intensity, as to be really and exquisitely painful. I do not here mean to enter into

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an enquiry concerning the source of the interest we take in spectacles of terror and distress. It is sufficient to observe, that just the same difficulty here occurs in reality, as in fiction. Every awful and terrific scene, from an eruption of Etna, or an attack on Gibraltar, to a street-fire or a boxing-match, is gazed at by assembled multitudes. In histories, is it not the page of battles, "treasons and murders," on which we dwell with most avidity? I do not hesitate to assert, that we never behold with *pleasure* in fictitious representation, what we should not have viewed with a similar sensation in real action. The truth is, that many of the tragic distresses are so blended with lofty and heroic sentiments, that the impression of sorrow for the sufferer is lost in applause and admiration.

When Cato groans, who does not wish to bleed? And when this is not the case, but pure misery is painted without the alleviations of glory and conscious virtue, the effects on the beholder are invariably pain and disgust. We are, indeed, by the strong impulse of curiosity, led to such representations, as the crowd are to fights and executions; but what man of nice feelings would go a second time to see *Fatal Curiosity*, or the butchery of a Damien?

With respect to the principle which renders a degree of *dramatic unity* necessary, it seems not difficult to be ascertained. *Congruity* is alike essential in real and in fictitious scenes to preserve a continuity

of emotion. After a pathetic speech in a play, if the actor immediately turns his eyes on the audience, or bows to the boxes, we feel the effect to be spoiled; why? because it is plain he is not the man he before appeared to be; for it is impossible that poignant sorrow should be immediately succeeded by indifference. Thus if a person were to ask our charity with a lamentable tale of woe, and suitable expression of countenance, and we should immediately afterwards detect him smiling or nodding to a companion, the first impression of pity would be lost in a conviction of fraud. A ludicrous incident on the stage interrupts the flow of tears in the deepest tragedy, and fills the house with general laughter. It is just the same in real life. At the funeral of a dear friend, at the death of a martyr, circumstances may occur, which not only divert the attention, but even provoke a smile. But such distractions in the real scene are short, and the true state of things rushes again on the mind. In imitative representations, on the contrary, they may be so forcible and frequent, as entirely to destroy the effect intended to be produced.

Incongruities in dramatic spectacles may be of various kinds. They may arise from the characters, the diction, or the fable. Those which proceed from the violation of what are termed the *unities of time and place* are, perhaps, the least injurious of any; for we find by experience, that the mind possesses the faculty of accommodating itself, with
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the greatest facility to sudden changes in these particulars. Indeed, where the fable will admit it, the intervention of *acts* renders the change of time and place no incongruity at all. For the drama is then a history, of which certain parts are exhibited in dialogue, and the rest in narration. Now, it is impossible to give a reason, why the mind, which can accompany with its emotions a series of entire narration, should refuse to follow a story of which the most striking parts are exhibited in a manner more peculiarly impressive. During the continuance, indeed, of the dramatic action, every thing should be as much as possible in unison; for as the stage is the most exact imitation of real life that art can invent, and in some respects even perfect, an inconsistency in one point is rendered more obvious by comparison with the rest. Thus, with regard to *time*; as the *conversation* on the stage employs the very same space of time as it would in a real scene, it seems requisite, that the accompanying *action* should not exceed those limits. If, while the stage has been occupied by the same performers, or an uninterrupted succession of new ones, the story should require the transactions of half a day to run parallel with the discourse of half an hour, we could scarcely fail to be sensible of an incongruity, and cry to ourselves, "this is impossible!" Such a circumstance would give a rude shock to the train of our ideas, and awaken us out of that *dream* of the fancy, in which it is the great purpose of

dramatic representations to engage us. For notwithstanding a critic of Dr. Johnson's name (whose heat and imagination, however, appear from numerous instances to have been very intractable to the efforts of fiction) has thought fit to treat the supposed illusion of the theatre with ridicule, I cannot but be convinced of the existence of what I have so often myself felt, and seen the effects of in others; and if the point were to be decided by authority, I might confidently repose on that of the judicious Horace, who characterises his *master* of the drama, as one,

qui pectus inaniter angit,
 Irritat, mulcet, falsis terroribus implet
 Ut magus; & modò me Thebis, modò ponit Athenis,

The notion of a temporary delusion produced by the imitative arts, and particularly by the drama, is, I observe, supported by Dr. Darwin, in the ingenious prose *Interludes* of his *Loves of the Plants*; and by arguments so similar to those here made use of, that it will be proper for me to say, that this short Essay was written some years before the appearance of that beautiful poem. The writer whom Dr. Darwin combats on this occasion, is Sir Joshua Reynolds, who seems implicitly to have adopted the opinion of his friend Dr. Johnson,

J. AIKIN,

*On the Uses of CLASSICAL LEARNING, by G. GREGORY,
D. D. Domestic Chaplain to the Lord Bishop of
Landaff. Addressed to DR. PERCIVAL.*

Read Nov. 4.

DEAR SIR,

IN all human pursuits, if we would form a just estimate of their value, a close and methodical examination of their uses and advantages is absolutely necessary. A man may read and write whole volumes of declamation, and yet not understand the subject, which has apparently occupied his thoughts. Without complimenting indeed unreasonably the age in which we live, (for in some instances it appears to have been extravagantly complimented) this, I apprehend, may at least be advanced with truth and modesty: that a more logical and less confused method of investigating truth, has been adopted of late years; senseless definitions, at first introduced by the school of Aristotle, are generally laid aside, and facts are appealed to with confidence, as the only basis of solid argument.

There are no subjects more universally interesting to mankind, than those which are connected with the education of youth; and I should humbly conceive that which I have chosen for the present Essay, not entirely unworthy the attention of your most respectable and eminently useful Society,

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Without wishing to disparage the pursuits of others; without presuming even to smile at the minute philosopher, whose life is consumed in contemplating and exploring the varied plumage of the butterfly, or who felicitates himself as the first of citizens, for having added a non-descript to the unbounded catalogue of mopes; without weighing the important consequences which are to result to the nation, from the fortunate discovery of a curious grave-stone, without promising our admiration to the voluminous disquisitions, with which certain laborious authors may chuse to entertain the public, on the tasteless variety of a tessellated pavement, or the shapeless fragment of some homely utensil; let it be our present business to explore the tracts of mind, to measure and calculate the value and utility of the noblest productions of human genius, and to view the growth and extension of reason and truth.

The study of ancient languages, the Greek and Latin at least, and of what are usually termed the classical authors in those languages, has, for some centuries, constituted a branch of liberal education, in every refined nation in this quarter of the globe. It appears, indeed, no more than a just tribute to the labours of antiquity, that posterity should not ungratefully consign them to unmerited oblivion; nor even content itself with contemplating that imperfect copy of their features, which a translation exhibits. It is a curiosity natural to the human mind, a becoming pride, to wish as intimate an acquaintance

acquaintance as possible with the illustrious dead; to hold, as it were, a friendly conversation with them, in their own language, and in their own peculiar style.

If these, however, were the only reasons for the cultivation of Classical Literature, though they might interest the philosopher, and the man of taste, still we could not in justice allow them that universal cogency, which is necessary to sanction a general Practice. There must be other motives to warrant the hardship, which is imposed on almost every well-born youth, of consuming in severe study, several of the most gay and delightful years of life, and of encountering hardships, which nothing but an object of some importance can justify.

Without wishing to appear a lover of paradox, permit me, dear Sir, to state that I do not in my own mind allow much force to the maxim which insists on the absolute necessity of classical learning in what are called the Professions. I confess, I think it a most pernicious pedantry which would involve in any kind of mystery, those sciences which are most essential to human happiness. The Christian world has been no gainer either as to piety or morals by speculative divinity; all that is necessary to mankind in theology ought to be, and I doubt not is, plain and easy to be comprehended by every capacity.—What! shall none but Greek and Latin scholars be permitted to make use of their reason on the most necessary topics? Admitting that there
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ought to be men in the christian church who should be able to read the holy scriptures in their original languages, to correct mistranslations, to compare and collate manuscripts, and to detect errors of every kind; must every plain country clergyman be an adept in languages, which cannot afford him the least assistance in instructing and informing the poor and illiterate flock, which is committed to his care? —He cannot preach in Latin; the plainest and least pedantic stile is that which will be most beneficial to his hearers; nay the rust of college manners, or the unyielding spirit of literary arrogance, are perhaps qualities, more directly than others, calculated to obstruct or to frustrate his pious labours.

In medicine, you, Sir, are I am sure too liberal not to see that the use of a dead language has certainly impeded, rather than advanced science. Who will pretend to alledge that the modern practitioner is obliged to have recourse to the ancients for the principles of his art? The English language, if we include the translations from foreign authors, contains a body of medicine, ample and voluminous enough to engage the attention of most practitioners, and to furnish them with every practical kind of information. Would it not really be better for mankind, would it not prevent the most fatal mistakes, if prescriptions were written in our own language, instead of those uncouth characters, which frequently appear like hieroglyphics, and are too often absolutely so to those who are to prepare the medicine? In
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short, ought not a science which concerns the first of temporal possessions, to be laid as open as possible to the reason of mankind?—Ought it not to be industriously weeded of all technical jargon?—Ought not every thinking person to be invited, as it were, to pay some attention to the progress of those diseases, which he may have an opportunity of observing, and to bring in with confidence, be they right or wrong, his quota of discoveries to the common stock? I do not believe such a circumstance would be injurious to the health of the community, or discouraging to the regular practitioner.—It is only by knowing a little of the outlines of medicine, that any person can estimate truly the value of a physician, or see the necessity of long instruction and much practice, to accomplish a man in this important art. Is it not the ignorance of the public on these points, that gives countenance to quackery, and is it not, because the science is treated as a kind of mystery, that every antiquated female is possessed of some infallible nostrum? In other arts or professions, the knowledge of Latin is not insisted on as a necessary qualification, and yet no person, not regularly brought up to them, presumes to intrude himself into these professions. In a word, let no man practice physic, who shall not be regularly educated or instructed in it; but in the name of reason, what has the writing or speaking of Latin to do with the cure of diseases?

I grant that some useful treatises in medicine are occasionally published in Latin, but these are few, and the argument will equally apply to the necessity of accomplishing the young physician, in all the European languages. In a word, let it be remembered, that I am not pleading against the utility of the dead languages, but in favour of their *general* utility, against the vulgar notion that they are only necessary to certain professions.

Of all branches of knowledge, the *Law* ought to be the plainest, and most easily understood. Praying in an unknown tongue is not half so great a solecism, as the involving in mystery and obscurity those rules, which are to govern the conduct of every individual citizen. How can I be expected to conform to laws, with which I am to be unacquainted, or which I cannot understand?—What indeed are the evils to which the inhabitants of this country are not exposed, on account of the complex and intricate nature of our laws? I must observe (and I do it with no intentional disrespect to the honourable and upright part of the profession) that all who are unfortunate enough to hold their property by any disputable title, or who have rashly exposed themselves in any way to the mischiefs of legal chicanery, are made the prey of one class of citizens; and it is almost proverbial, that of all English commodities, Justice is by far the most expensive. If any part of what I have urged on this topic, be consistent with fact, ought a classical education to be considered as a *necessary* qualification

qualification for understanding what all ought to understand?—No, Sir, the uses of classical learning are not partial but general, and not confined to a particular profession.

It must be confessed, that with respect to the cultivation of the dead languages, society is at present in a very different state from what it was at the revival of Letters. At that period, all the science, all the history, all the taste which existed, were locked up in the volumes of the Ancients; there was no access to any branch of knowledge but by this path; it was necessary to be introduced to this enlightened school, or to remain in barbarism and ignorance.

In the present state of literature it would be disingenuous to deny, that it is possible for a person, not classically educated, to make a proficiency in almost any department of science or literature.

In medicine and philosophy some persons might be named, of no inconsiderable eminence, with but a very slender portion of Greek or Latin. In law and politics also some instances might be adduced, were not a false pride unfortunately predominant, which might construe into an affront, what is really a compliment. The ladies may be cited with less ceremony on this occasion. In history and philosophy we have a Macaulay; in poetry a Seward and a Williams; in morals a Burney; in dramatic writing a Cowley and an Inchbald, all unacquainted with the languages and compositions of the ancients. It does not, however, follow, from these splendid examples,

that the shortest and easiest way to knowledge and excellence, is through the medium of our mother tongue, and that a classical education is of no utility whatever. One lesson indeed we may deduce from what has been advanced on this topic, and that is, to look with a less fastidious eye upon those, who without these advantages (for advantages they certainly are) have made good their progress to eminence and fame.

In estimating the uses of a classical education, it is necessary to confine our views entirely to the *present state* of literature, for indubitably a few centuries ago its advantages were infinitely greater, it was indeed not ornamental, but essential to science. Discarding, therefore, as much as possible, every prejudice of every kind, the real uses of a classical education appear to be nearly as follow.

I. In the first place, grammar, and perhaps orthography, are assisted, by an early acquaintance with the dead languages. I would not be understood to assert, that a person may not be practically versed in both these branches, without any such assistance, but it is a question, whether almost an equal portion of time is not consumed in the attainment of them, through the ordinary medium of English grammars, &c. Besides this, I am apprehensive that a complete, an enlarged, a scientific acquaintance with the principles of grammar, is hardly to be obtained, without the knowledge of some other language than our own. The grammar of the Latin language is more
regular

regular than that of any other, and it is therefore admirably calculated to initiate young persons in that necessary science.

II. A similar advantage, which flows from a classical education, is a general knowledge of the structure of language. The Greek, so copious, so curiously compounded, so admirably adapted to supply every want of the mind with respect to expression, affords the happiest instance of art and human invention in the construction of language; it is impossible to study it without perceiving our ideas enlarged and improved on this curious subject. Such an acquaintance with the ancient forms of language, enables us to improve our own, to extend and diversify our modes of expression, to add new and proper words, if necessary; and gives us confidence in occasionally introducing new expressions, and deviating from the common and colloquial forms.

III. A third use, which is not less obvious, results from an accurate acquaintance with the etymology of words. To the phrases of common life, custom has sufficiently familiarized us, and these indeed are most of them derived from our northern ancestors. But the language of science, the language of books indeed, in general, is of classical origin; and it is impossible to know the full force, the correct application of words, without, in some degree, being acquainted with their source.

Every man who has composed for the public, must be sensible of this observation; and allowing every thing

thing to genius and industry, still it cannot be denied that accuracy in writing, at least, is almost exclusively the characteristic of those, who can boast some acquaintance with the languages of antiquity.

IV. It is some commendation of almost any pursuit, to say, that it affords us an elegant and an innocent amusement. That it engages occasionally the mind, which, perhaps, would otherwise be the prey of spleen; that it fills up agreeably those hours, which, if left vacant, might perhaps be contaminated with vice;

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Posces antè diem librum cum lumine; si non
Intendes animum studiis & Rebus honestis,
Invidia vel amore vigil torquebere.

It is true there are a number of excellent authors in our own language, but still the perusal of the classics, in their original dress, varies and extends this species of entertainment.

V. It is pleasant to observe the manner of an original author, and instructive to remark the peculiar style, in which men of exalted genius have, at such distant periods, expressed themselves.

VI. Have you ever remarked, Sir, that from the perusal of an original author, one seems to form a more perfect picture of the manners and characters of the age which he describes, than can be acquired by a translation? I think Homer is a striking illustration of this fact; indeed, one of the great uses of the *Iliad*, has always appeared to me, to be
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the light which it reflects on the history of mankind, in the early periods of society.

VII. Whoever expects to find in the ancients the perfection of science, will be disappointed; but this will not warrant us in a total rejection of all the assistance which may be derived from this source. Of natural knowledge, in particular, there is certainly but little to be collected from their writings. Aristotle, in his history of animals, is a laborious and tolerably correct reporter of facts—but how small a branch of natural science is this, and how much better detailed by modern writers? Pliny, except where he has copied Aristotle, is a wretched fabulist, and no reasoner at all.

The metaphysics of Plato are subtil, visionary, and useless; those of Aristotle are mere scholastic definitions. In the republic of the latter, as well as in some of the writings of Xenophon and Cicero, are some good political observations; but the experience of the moderns, has enabled them greatly to improve this important science.

But if the ancients were deficient in these topics, they were not so in what may be considered as the basis of useful knowledge, in morals, and an extensive acquaintance with the human heart. Though I confess I do not find much of ethical science in Plato, which is deserving of attention; yet in the *Απολλωγία* of Socrates, and some other of the dialogues, there occur some beautiful reflections. The morals of Aristotle are a dry common place book,
chiefly

chiefly consisting, like the rest of his philosophy, in definitions. In the writings of the stoics, however, some admirable precepts are to be found—indeed we may go further; we may venture to say, there is something of principle in the doctrines of these philosophers; they mould ethics into a kind of science, and distinguish with accuracy the different stages of human perfection.

Απαιδεύεις εργον, το αλλοις εγκυκαλειν, εφ' οίς
 αυτῷ πρασσει κακως. ηργυμεναι παιδευεσθαι,
 το εαυτῷ. πεπαιδευμεναι, το μητ' αλλω,
 μηθ' εαυτῷ.

Epic't. Enchirid. c. 10.

Ιδιῶς ζασις και χαρκαλινρ' εδεποτε εξ' εαυτῷ προσδοκων
 ωφελειαν η ελαβην, αλλ' απο των εξω. Φιλοσοφῃς ζασις και
 χαρκαλινρ' πασαν ωφελειαν και ελαβην, εξ' εαυτῷ προσδοκων.

Ib. c. 71.

Without the rage for definition so obvious in Aristotle, their distinctions were happier, more accurate, and more agreeable to nature.

Ουτοι δε οι λογοι ασυνακλοι. εγω σε πλεσιωτερος ειμι, εγω
 σε αρα κρεσσων. εγω σε λογιωτερος, εγω σε αρα κρεσσων.
 εκαντοι δε μαλλον συνακλοι' εγω σε πλεσιωτερος ειμι, η εμη
 αρα κλινσις της σης κρεσσων. εγω λογιωτερος, η εμη αρα
 λεξις της σης κρεσσων. συ δε γε ετε κλινσις ει, ετε λεξις.

Epic't. Enchir. c. 66.

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These ideas are differently, and perhaps, still more sublimely expressed by Antoninus.

Θάνατος δὲ γέ καὶ ζῶη, δόξα καὶ ἀδοξία, πόνος καὶ ἡδονή, πλεῖς καὶ πένια, πάντα ἐπίσης συμβαίνει ἀνθρώπων τοῖς ἢ ἀγαθοῖς καὶ τοῖς κακοῖς, ὅτε καλὰ ὄντα, ὅτε αἰσχροῖς.

Anton. Lib. II. c. 11.

Τὰ ἀνθρώπινα εἰς ὁ μὲν χρόνος, σιγμή· ἢ δὲ ἔστι, βρῆσα· ἢ δὲ αἰσθήσεις, ἀμύδρα. ἢ δὲ ὅλα τὰ σωματικά συγκρίσεις, εὐσηπτός· ἢ δὲ ψυχὴ ῥόμβος· ἢ δὲ τύχη, δυσεκμαρτόν· ἢ δὲ Φήμη ἀκρίβιον, Συνελόνι δὲ εἰπεῖν, πάντα ἴα μὲν τὰ σωματικά, πόλαμ· τὰ δὲ τῆς ψυχῆς, ὄναρος καὶ τυφός. ὁ δὲ βίος, πολεμὸς καὶ ξένος ἐπιδήμια· ἢ ὑπεροφήμια δὲ, λήθη. τί ἐν τῷ παραπεμφαί δυναμένον; ἐν καὶ μόνον, Φιλοσοφία. ἴσ-
το δὲ, ἐν τῷ τηρεῖν τὸν ἑνδὸν δαίμονα ἀνυβρίζον, καὶ ἀσινῇ, ἡδονῶν καὶ πόνων κρείσσονα, μηδὲν ἐνὶ ποιῆναι, μηδὲ διεψευστμένως καὶ μεθ' ὑποκρίσεως, ἀνενδεῇ ἢ ἄλλον ποιῆσαι τι, ἢ μὴ ποιῆσαι.

Ib. L. ii. c. 17.

ὁδᾶμε γὰρ ὅτε ἡσυχιώτερον, ὅτε ἀπραγμονεσέρον ἀνθρώπος ἀναχωρεῖ, ἢ εἰς τὴν ἑαυτοῦ ψυχὴν· μαλίσθ' ὅστις ἔχει ἑνδὸν τοιαύτα, εἰς ἃ ἐγκυψας ἐν πασῇ εὐμαρείᾳ εὐθὺς γινεῖται.

Ib. L. iv. c. 3.

Nor is there wanting a higher philosophy for a basis to these reflexions : speaking of death :

Τὸ δὲ ἐξ ἀνθρώπων ἀπελθεῖν, εἰ μὲν θεοὶ εἰσιν, ὅθεν δεινόν· κακῶ γὰρ σε ἔκ ἀν περιβαλοῖεν· ἢ δὲ εἰ τι ἔκ εἰσιν,

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ἢ ὅ μελεῖ

ἢ ὃ μελεῖ ἀνδίοις τῶν ἀνθρωπείων, τι μοι ζῆν ἐν κόσμῳ κενῶ
 θείων, ἢ προνοίας κενῶ; ἀλλὰ καὶ εἰσι, καὶ μελεῖ ἀνδίοις
 τῶν ἀνθρωπείων.

Anton. Lib. ii. c. 11.

Τὰ τῶν θείων προνοίας μετέμ. τα τῆς τύχης ὅτι ἀνευ Φύσεως,
 ἢ συγκαλώσεως, καὶ ἐπιτοκῆς τῶν προνοίας διοικημένων.

Ib. c. 3.

It must, however, be confessed of the Stoic morality, that much of it is extravagant, and some of it trifling; that it is built upon too few principles, abounds with repetition, and, perhaps, justly incurs the censure of (I think) Lactantius; that it was calculated for actors on a theatre, and not for men in the world.

The most regular and methodical tract upon ethics, which is contained in the whole scope of classical literature, is the offices of Tully; this valuable fragment contains much excellent reasoning, and much sound observation—but, still it appears to me but a fragment. Whether the lively and desultory genius of Cicero, revolted against the toil of a laboured, methodical, scientific production, or whether he was interrupted in the progress of his task, the work is certainly imperfect; there are several useful topics entirely omitted, and even the system itself is left in an unfinished state.

In the other beautiful rhapsodies of Tully, in vain shall we look for any thing like system or
 method.

method. No man, however, can read his Cato Major, his De Amicitia, his Tusculan Disputations, without moral improvement; his letters, and all his writings, abound in animating and interesting reflexions, in excellent maxims. There is a point, a force, a climax too in his observations, which cannot be too greatly admired, and carries the mind along with it, and which gives a novelty even to what is common place in itself:

“ Et nomen pacis dulce est, & ipsa res salutaris; sed inter pacem & servitutem plurimum interest: Pax est tranquilla libertas, servitus postremum malorum omnium, non modò bello, sed mortē etiam repellendum,”

Cic. in M. Ant.

“ Sin aliquando necessitas nos ad ea detruferit, quæ nostri ingenii non erunt: omnis adhibenda erit cura, meditatio, diligentia, ut ea si non decorè at quam minimum indecorè facere possimus.”

Cic. de Off.

In the writings of the Poets, the most useful and beautiful reflexions are expressed with a simplicity which delights, or a force which penetrates the heart; the former is chiefly the characteristic of the Greek, the latter of the Roman Muse:

ΕΦ' ἣ σὺ μαινῇ· Κενο καλλιστον, Τεκνον,
Ἰσοίηλα τιμῶν, ἢ Φίλος ἀεὶ Φίλοις,

Πολεῖς τε πόλεσι, ζυμμάχους τε ζυμμάχοις
 Συνδει. το γὰρ ἴσον, νομίμον ἀνθρώποις ἔφν,
 Ἔω πλεονὶ δ' αἰεὶ πολεμικὴν καθίσταται
 Τελασσον, ἐχθρὰς δ' ἡμέρας καθαρχειται.
 Καὶ γὰρ μετρ' ἀνθρώποισι καὶ μερὴ σαθμῶν,
 Ἰσότης ἔλαξε, κ' ἀριθμὸν διωρισε.
 Νυκλὸς τ' ἀφεγγες ἔλεφαρον, ἡλὺς τε φῶς,
 Ἰσὸν βαδίζει τὸν ἐνίκυσιον κυκλόν·
 Κ' ἐδελερὸν αὐλοῖν φθονὸν ἔχει νικῶμενον.
 Εἰδ' ἡλῖος μὲν, νυξ τε δαλευεὶ θροοῖσι.

Eurist. Phœnist. 548.

Ὄνομα γὰρ, ἔργον δ' εἴς ἐχαστὶν οἱ φίλοι,
 .. Οἱ μὴ 'πὶ ταισὶ συμφοραῖς ὄντες φίλοι.

Id. Orest. 455.

The animated and rational morality of Horace, cannot be too closely studied—What a fund of fine observation, and judicious admonition, is contained in his satires?—With what grace and vivacity does he recommend the practice of virtue, and the cultivation of knowledge, in his elegant epistles? The satires of Juvenal and Persius, not only present us with excellent pictures of local manners, but with much general and useful instruction—But I feel, that what would be information to the unlearned, is trite and common-place to the learned society, which, through your medium, I am addressing—I therefore stop my pen, admonished, also, by the ordinary limits of a literary memoir.

If

If HISTORY be classed among the sciences, in this the ancients cannot be too warmly commended. To their admirable writings we are indebted, not only for the most important facts in the history of mankind, but for the most perfect models in that species of composition. I think, Sir, the ancients have not been equalled in this line, and I think I can venture to say, that I have not seen the sweet simplicity of Herodotus—the dignity of Thucydides, the harmony and elegance of Sallust, or the pointed and forcible expression of Tacitus, transferred into any modern language, by their most learned translators.

VIII. But whatever was wanting to the ancients, in science, is amply compensated in taste. Homer and Virgil are, I think, still unrivalled, and the latter of them is certainly still untranslated.—The pastorals of Theocritus, and perhaps the odes of Pindar, are without parallels in modern languages.—The satires of Horace and Juvenal have only been imitated.—In every department of prose composition also, we find among the ancients the most perfect models. The clear and energetic reasoning of Demosthenes, the full, harmonious, and ornamental periods of Cicero, and the sententious neatness of Sallust, have never been excelled. To form, therefore, a correct taste, the easiest and most effectual mode, is certainly by a well directed study of these inestimable compositions, and by occasionally comparing them with the excellencies and defects of modern productions.

If

If in any department of polite literature, which they have cultivated, the ancients have failed, it is in the drama; whether owing to the defects of their theatres, which admitted no change of scene, or whether we are to consider the drama, as one of the most improveable branches of literature, and as then being only in its infancy, I must confess to you, my dear Sir, that there are scarcely any productions, which I find so uninteresting, as the Greek tragedies. The uniformity, the nothingness of their plots, their tedious declamations, and their snip-snap dialogue, are poorly compensated for, by a few elegant odes, and a few beautiful or striking sentiments. If one play of Terence (the *Andria*) only had been left to posterity, he would rank among the first of dramatic writers, but after reading this, who can admire any other of his productions? Aristophanes and Plautus are as much beneath our common farce writers, as the best of the ancient dramatists are inferior in excellence to Shakespear and Moliere.

There are some other branches of literature, in which I think the moderns have excelled, and some which have not at all been cultivated by the ancients; but this does not, in any view, militate against the utility of classical literature, as an accomplished person ought to be acquainted with the most perfect productions, both of ancient and modern times.

From a fair consideration of the real uses of classical literature, some practical conclusions result, which
appear

appear of no inconsiderable importance in the education of youth.

Impressed as I am, with a full sense of the advantages resulting from a classical education, I cannot help thinking, that an unreasonable and enthusiastic regard has sometimes been paid to the writings of the ancients. Instead of considering them as useful assistants, as guides to knowledge, they have been extolled, as containing within themselves, all that is worthy of being known, and men have mistaken the rudiments of science, for science itself. How many have devoted their lives to the study of the classics, as if there were no other duties to be performed, no other advantages to be obtained, no other laurels to be reaped? How many have continued, during their existence, in the elements of science, without extending their views to any thing beyond them, without indeed making use of their own understanding.

I should wish to see the ancients studied for their matter, as well as for their language—But the information which they convey, is too commonly made a secondary consideration. The attention of youth is directed to the elegant latinity of Cæsar and of Horace, not to the facts, observations, or precepts, which are contained in these valuable authors. If the tutors of our youth, condescend to remark even upon the beauties of the classics, it is not on the beauty of sentiment, it is not on the beauty or vigour of imagination, it is not on the poetical ornaments.

ornaments.—Their attention is at the utmost extended to a choice of words, to a curious grammatical connexion, or to the nice intricacies of idiomatical phraseology.

At the revival of letters a race of commentators were useful, if not necessary; they were the pioneers of literature, who cleared the way for more respectable adventurers. But in the present state of literature, can we behold without regret a man of genius dedicating a life to a few barren and fruitless verbal Criticisms, to the regulating of a few phrases, or correcting in a few instances the quantity and metre of an obscure Author; when, had he applied his talents as they ought to have been applied, he, perhaps, would have produced an original composition, more valuable than the production on which he has so unworthily bestowed his labour?

To write Latin decently and intelligibly, may occasionally prove a convenience to a literary man; chiefly in facilitating his commerce with foreign literati; but surely the attempt (for it is but an attempt) to compose poetical productions in Greek and Latin, is, at best, only a species of elegant trifling. If life be short, and science of unbounded extent; if our duties be many, and but few our opportunities of qualifying for them, and performing them as we ought, are we justified in neglecting solid and useful branches of knowledge; are we to pursue straws, and leaves, and Gossamer, while we
leave

leave the grain and fruits, which should be the support of life, to perish and to rot?

The example of some of our enlightened neighbours on the continent, may, perhaps, be worthy our imitation. They study the ancients, but they study them to read and imitate them. They are not devoted to this study alone; they make themselves masters not only of the ancient, but of the modern languages; they can converse with the well informed of other nations, and they can read their works. Thus an infinite extent of knowledge is opened to their view; and they are less likely to be the slaves of prejudice than the cloistered pedant, who expects to find the whole of knowledge in the blind reveries of ancient scholiasts—whose philosophy is locked up in Plato, whose morals and politics are only derived from Aristotle, and who regard the tales of Pliny, as the perfection of natural science.

It is by estimating truly the advantages of classical learning, and not by over-rating its importance, that we can give it respect, or promote its cultivation.

I think an acquaintance with the ancient languages, essential to the formation of an accomplished character; but if a man would be accomplished he must not stop there—he must not expect to find in the ancients what they do not contain; or “see in Homer, more than Homer knew.”

R

Were

Were I to chuse a preceptor for my own children, I should certainly prefer a man of general knowledge. A man who was conversant with modern literature and modern science, as well as with the ancient writers, would certainly improve the taste, would certainly enlarge the understanding of young persons, more than the mere Classic, even though the latter should make Latin verses with greater facility.

In a word, without neglecting the ancients, we may derive much wisdom, much taste, and much pleasure from the productions of modern writers; the study of both is compatible, if we study both as we ought.

I owe many apologies, Sir, to your respectable Society, for the unfinished and imperfect state in which this Essay is presented. You were pleased to call upon me for some contribution to your valuable fund of literary and philosophical information, and I was unwilling to raise your expectations by delay. In the midst of a laborious life, and a series of interruptions, I have snatched a few moments to arrange my ideas on a subject, which I should wish to see taken up by some abler hand, but which appeared of too much importance to be utterly neglected.

I am, dear Sir,

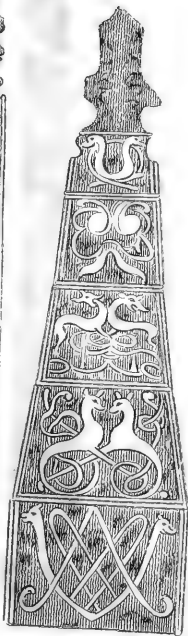
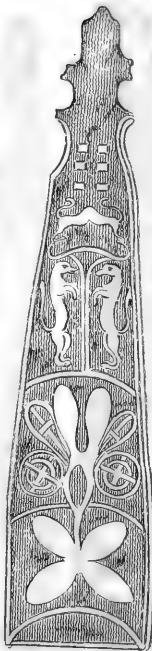
With much respect,

Your most faithful servant,

G. GREGORY.

*Winkworth Buildings,
April 9th. 1791.*





A Dissertation upon the ANCIENT CARVED STONE MONUMENTS in SCOTLAND, with a particular Account of one in Dumfrieshire, by ROBERT RIDDELL, of Glenriddell, Esq. Captain of an Independent Company of Foot, F. A. S. and Member of the Literary and Philosophical Society of Manchester.

Read Dec. 2, 1791.

THERE is not perhaps a more universal feature in the history of man, from the most early dawn of historical information to the present advanced period, than that every nation before the introduction of letters, made use of Hieroglyphical symbols to communicate to their posterity their discoveries in the arts and sciences, the fundamental principles of their religion and laws, and the most celebrated exploits of their princes and heroes.

In Egypt we find many monuments remaining covered with hieroglyphic symbols, the art of deciphering which was entirely lost in the time of Herodotus, the historian; and when Hernando Cortes conquered Mexico, the most civilized of any American nation, we find they then transmitted their annals to posterity by hieroglyphical and symbolical paintings.

In Scotland, particularly along the East, many hieroglyphic Monuments are still to be met with.

Mr. Gordon, in his *Itinerarium Septentrionale*—Mr. Pennant, in his *Tour in Scotland*, and the Rev. Mr. Cordiner, have given to the world prints, accompanied with descriptions of many of these monuments, in their respective elegant and useful publications. Captain Grose and Mr. de Cardonnel have it in their power to add considerably to these monuments already published.

They appear to have been the work of the Scotch Norwegians and Danes, perhaps from the ninth and tenth centuries to the time of David Ist. when the general use of letters over all Scotland, rendered laboured sculptures of this kind unnecessary. Several of them bear undoubted marks of their being erected by Christians—others I believe to have been the work of Pagans.

In Dumfries-shire are the remains of some of these very ancient Monuments. The one in Ruthwell church-yard has been published by the Antiquarian Society of London, with very great accuracy and elegance, from a drawing of Adam de Cardonnel, Esq. and the one I mean to describe has been delineated with the utmost fidelity by the accurate pencil of my learned friend Francis Grose, Esq. F. A. S.

This very ancient obelisk stands upon the banks of the river Nith, near the village of Thornhill, in Nithsdale, a district of the shire of Dumfries—Mr. Maitland is the only Scottish historian I can
at

at present recollect, who has taken notice of it, and he does it very slightly.

All tradition respecting it is lost; so that the date of its antiquity can be conjectured only by comparing it with those published in the before-mentioned works. It is a stone about fourteen feet in height, with a pedestal, or socket, into which it is sunk, rudely hewn into two steps. At the bottom where it rises from the pedestal, it is two feet in breadth, tapering at the top to twelve inches. The sides or edges at the bottom are about six inches, tapering at the top to four.

The one side has five distinct co-partments, besides a space at the top, wholly defaced. The opposite side appears to consist of two co-partments, and is much more defaced than the other. The sides or edges are carved in an elegant kind of chain pattern. Upon the two sides are figures of animals, the bodies of which are formed into unnatural and grotesque shapes, but the annexed drawing will convey a better idea of this Monument than it is possible to describe in words.

A gentleman from Ross-shire informed me, that in the island of Lewis, there still stands a very entire and highly ornamented Stone pillar, not much inferior to the one near Horres, either in point of size or carving. The remarkable circumstance attending this Obelisk is, that it stands on a small hill in the midst of an almost inaccessible bog, some miles from the sea. It is the general opinion

nion that it must have been brought to the island, as there is no stone to be seen in Lewis of the same kind as this Obelisk. I have made applications to different gentlemen in the neighbourhood to procure a drawing of this stone pillar, but have not as yet been able to procure one.

I have often thought that were drawings of all those carved Monuments in Great Britain and Ireland collected into one work, they might then be classed by an Antiquary, well versed in the Runic, Celtic, and ancient Irish characters; and then perhaps, it might with certainty be determined whether they were intended to mark the sepulchres of heroes—the fields of battles—or to record historical events, or religious ceremonies.

OBSERVATIONS

OBSERVATIONS on ALPHABETICAL CHARACTERS; and particularly on the ENGLISH ALPHABET: with an Attempt to shew its Insufficiency to express, with due Precision, the Variety of Sounds, which enrich the Language. — By Mr. SAMUEL HARVEY.

(Read by the Author March 23, 1792.)

AN CUJUSLIBET AURIS EST EXIGERE LITERARUM SONUS? NON, HERCULE, MAGIS QUAM NERVORUM.

Quinctill. Instit.

SECTION I.

SO much has been already written, in commendation of the English Language, that it would be superfluous in this place to add any thing to the eulogies which have been, from time to time, bestowed thereon: and indeed so numerous are the sources, whence, as from various treasuries, it has derived its riches; and so many and excellent those authors, who, for more than a century past, have, by their writings, been superadding dignity and reputation thereto, that its superiority, above many languages which might assert a much higher antiquity, has been for some time acknowledged, by those whom we ought not to suppose actuated by partiality;

tiality; by Foreigners of distinguished abilities, well versed in the works of eminent English authors, and who themselves were such masters of the language, as to write it with elegance and ease; and possessing, withal, such an acquaintance with other languages as enabled them, by comparison, to become the most accurate arbiters of the worth of each. A very flattering character of our language is given by MR. BARRETTI,* in the preface to the second

* It can hardly be necessary to remark what is so well known—that this ingenious writer was formerly Secretary, for foreign correspondence, to the Royal ~~Society~~^{Academy}; and one of the intimate friends of DR. JOHNSON, &c. And he frankly observes that (before he was acquainted with England) conceiving, that after a knowledge of Greek and Latin, nothing further but French could be necessary to form the *ne plus ultra* of every well-bred gentleman, he applied himself to acquire it; and having read the works of Montagne, Pascal, Malbranche, Corneille, Moliere, la Fontaine, &c. imagined that there was not any thing which could possibly come in competition therewith: “ma molto piacevolmente,” says he, “m’aveddi essermi ingannato a partito allora che mi trovai mediocrement maestro del Britannico parlare. Oh quante belle e grandi cose Paesani miei, ho lette in questi libri che non si leggono in quelli d’altre genti! Passerò in silenzio un Hooker, uno Scot, un Clarke, un Bentley, uno Stillingsfleet, un Tillotson, e centinaja d’altri loro teologi e sacri oratori che valorosamente battagliando contra i numerosi sceredenti del loro e d’altri paesi, hanno in mille modi e poco meno che con geometrica evidenza provata la verità della religione rivelata, così che hanno costretti gli Ateisti e i Deisti a rifugiarsi negli sterili deserti dell’ ignoranza, o a nascondersi nelle

second volume of his Italian Dictionary; and, with such a character, it is a pity that it should have any faults; yet some it has, and will probably long retain, as excrescencies too nearly attached and too long growing with it to admit of being removed, without some difficulty. Here I more particularly allude to its

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Alphabet,

caliginose cave della mentecattagine. Non dirò verbo de' loro filosofi e cercatori diligentissimi della natura, come a dire un Bacono, un Boyle, un Newton, e tant' altri scrutinatori dell' uomo e dell' altr' opere della mano onnipotenti. Lascero indietro i loro tanti moralisti, i loro politici, gl' istorici e cronologisti loro, i meccanici numerosissimi, e farò solamente alcune poche parole de' loro poeti, perchè *questo è l'umore dove io pecco*, per servirmi d'un modo di dire del nostro Berni. Quanto carta però non mi converrebbe scarabocchiare per darvi solo una malabbozzata idea d'uno Shakespeare, d'uno Spencer, d'un Milton, d'un Dryden, e di molt' altri divini spiriti, che accozzando chi più chi meno alla schiettezza della poesia Greca, la venustà de' Latini, la vaghezza degl' Italiani, e la nitidezza de' Francesi con la robustezza e fantasticagine della Sassonia e delle Gaule hanno prodotta una maniera di pensar poetico, della quale noi successori del Lazio e imitatori di quegli antichi dell' Acaja non ci curiamo ancora quanto dovremmo fare, contentandoci troppo mansuetamente che i nostri Poeti abbiano con iscrupolosa industria modellati i pensieri loro e il loro modo di poetare sugli esemplari Greci e Latini.*

* After what better models could they have formed their thoughts? The advice of Horace ought certainly to have some weight :

Vos exemplaria Græca
Nocturnâ versate manu, versate diurnâ,

Alphabet, in respect to marking that variety of sounds, in which it is certainly richer, as I shall by and by attempt to prove, than many of the modern languages; though as to characters for expressing those sounds with due exactness, there are undoubtedly few languages so deficient.

It is not my intention, however, to write an essay upon the general construction of the language; neither shall I here endeavour to recapitulate all the various conjectures, which have been written, relative to the invention of alphabetical characters; nor shall I dwell upon the history of their improvement, progress, and diversity; as these are circumstances, wherewith almost every one is well acquainted: But I shall confine this paper chiefly to some observations, on the variety of sounds in the English language, and the impossibility of a distinct and rational notation thereof by our present alphabet, perverted as it too often is; with such reference to the Alphabets of other languages, as may serve to elucidate and explain the subject; and with such authorities, as may testify its importance. And though, perhaps, it would require a long series of years to improve our Alphabet, by repairing its defects, and pruning away its redundancies, yet certainly the enquiry should not be deemed contemptible; since, as a learned and ingenious Member of this Society* well observes: "Of all human

* See *Essays Historical and Moral*, by the Rev. G. Gregory, D. D.

arts, the most curious, and apparently the most difficult of invention, is ALPHABETICAL WRITING."

Now a variety of Alphabetical Sounds, and a copiousness of apt words for the greatest number of ideas, may justly entitle a language to the epithet, *rich*; but in order that it should be still more nearly allied to perfection, it ought not only to possess words and sounds, but also an orthography; nevertheless, if the French language be excepted, I know of none which has less of orthography, than the English; though it be as nervous and as abundantly supplied with words of all kinds, as any of the modern languages.

Every one knows, that orthography does not merely signify spelling, or putting letters and syllables together, but the doing so correctly; and howsoever capriciously, or defectively a language may be used, as to its orthography, or the just combination of its elementary characters, yet there can only be one uniform law to regulate it in this respect: "*et potius ab incorrupto principio, ab naturâ rerum, quàm ab libidine hominum.*"*

In the English language there is a strange confusion of vowels and consonants heaped together; in many places redundantly: Diphthongs are not infrequently used for vowels; and both are sometimes compelled to serve as consonants, or rather to rank amongst them by name, though indeed they are not in a

less degree vowels or diphthongs, from being termed consonants. Now to mistake these and use them indiscriminately and unnaturally, though the words, wherein they are so used, may, like some hieroglyphics, be from habit, well understood; yet it must assuredly be acknowledged as a blemish to the appearance, and some little impediment to the arts of writing and printing, to employ a superfluity of letters where fewer would suffice, if due deference were paid to the simplicity of nature, and the analogy of reason. For, in order to produce harmony from the combination of principles, whether it should be in painting, music, or language; or in short, in any subject improveable by art, analogy and proportion should be carefully regarded. “*Quæ enim est pars mundi quæ non innumerabiles habeat analogias? Cælum an mare, an terra, an aër, et cætera quæ sunt in his?*” *

Should any one, therefore, wish to excel in the practice of painting, or of music, he ought without doubt, to be well acquainted with the nature and variety of colours, ere he should attempt to mix and spread them on his canvas; or with the proportionate and most minute divisions of sound, suitable to composition, before he should attempt to write a Solo or Concerto. So in painting words to the eye, it seems in the first place necessary to understand the elements, of which, according to their various inflections,

* Ter. Varronis De Ling. Lat. lib. viii.

tions, they ought to be composed, in order to establish that unity and precision, which should characterize every work of art: Hence such an attention to elements would render language cognizable, as well by the sight as by the organs of hearing, and prevent the errors of one sense, which so often arise (especially when foreigners are acquiring our language) from the mistakes of the other.

It is true, indeed, it may be urged, that our Alphabet, in its present state, has, for at least two centuries, very well answered all the purposes of writers of every description. So, there is reason to suppose, did the Cadmean letters serve three thousand years ago, for the writers of that age, till Palamedes found out that three or four letters more would do better; and perhaps these seemed enough, till Simonides added as many others as Palamedes had done before.*

Habitual error may sometimes be mixed with reason, and mistaken for one perfect whole; but as truth and falsehood can never be so altered as to incorporate together, to analyze appearances, and to separate truth from its semblance, is the certain means of approaching nearer to perfection.

If

* Quippe fama est, Cadmum, classe Phœnicum vectum, rudibus adhuc Græcorum populis artis ejus auctorem fuisse, Quidem Cecropem Atheniensem, vel Linum Thebanum, et temporibus Trojanis Palamedem Argivum memorant, sexdecim litterarum formas; mox alios, ac præcipuum Simonidem, cæteras reperisse. Lallemand's Tacitus, vol. ii. page 13.

If any one, nevertheless, should chance to be so completely satisfied with our mode of forming words, as to think that there is not *any* room for its improvement, he must indeed be a very superficial, or a very precipitate observer; since nothing can be advanced in defence of defects which an easy investigation would enable him to condemn, but, that necessity alone has so long retained them. For, indeed, however they may be examined, it is to be feared that the faults of our Alphabet are too inveterate to allow of being, in any short time, effectually repaired, unless (which would be vain to expect) all the literature of the English language, worth preserving, should be reprinted. This much, however, may be derived from the examination, that it may possibly excite some further curiosity and enquiry concerning a subject, which, without question, is not too far beneath the pride of man, or the stubbornness of opinion to investigate: “Ne
 “ quis (igitur) tanquam parvæ fastideat Grammatices
 “ elementa: non quia magnæ sit operæ consonantes
 “ à vocalibus discernere, ipsasque eas in semivocalium
 “ numerum, mutarumque partiri; sed quia interiora
 “ velut sacri hujus adeuntibus, apparebit multa
 “ rerum, subtilitas, quæ non modo acuere ingenia
 “ puerilia, sed exercere altissimam quoque erudi-
 “ tionem ac scientiam possit.”*

The

* Quintill. Institut. Lib. ii.

The Hebrews go still further in support of the dignity of letters, as may be seen at the beginning of the younger Buxtorf's Chaldaic Lexicon, when they say "that there is not a single letter in the law, whereon the fate of vast mountains may not be suspended."

If we consider the facility wherewith, by means of a few letters, the communication of all human ideas is effected, and the most important employments of life promoted, all other modes of transmitting intelligence and recording the history and science of the world must hold a very inferior place in the comparison. And yet there are people, whose numerous productions are indubitable proofs of their ingenuity and industry, who are, notwithstanding, such enthusiastic worshippers of custom, that, though they might acquire a readier and more rational method of imbibing and communicating knowledge; prefer, however, in defiance of all its difficulties, their own most numerous, complicate, and almost unattainable scheme of arbitrary characters.

More tardy and difficult, however, than this scheme of Chinese writing (though in representing visible things more precise) must that of the Mexicans have been, whereby they recorded* all their events; and were enabled to report to Motezuma all that they had observed amongst the Spaniards: "Era esta su modo de escribir, porque no alcanzaron el uso de las letras, ni supieron fingir aquellas señales, o elementos, que inventaron otras naciones para

“ para retratar las sylabas, y hacer visibiles las palas-
 “ bras; pero se daban à entender con pinceles,
 “ significando las cosas materiales con sus proprias
 “ imagines, y lo demas con numeros, y senales
 “ significativas: en tal disposicion, que el numero,
 “ la letra, y la figura formaban concepto, y daban
 “ entera la razon.”*

How tedious and imperfect would this practice be found if it should be put in competition with the most complex alphabetical writing! Though it would be much easier to invent a multitude of arbitrary characters than retain the remembrance hereof; yet human invention would be exhausted in this case, ere half the changes of any common alphabet should be completed. Perhaps this may be amply evinced by the following curious theorem, which Mr. Harris has inserted in his *Hermes*, a work too well known, to stand in need of any additional praise: “ Mille millones scriptorum mille
 “ annorum millionibus non scribent omnes 24 lite-
 “ rarum alphabeti permutationes licet singuli quotidie
 “ absolverent 40 paginas, quarum unaquæque con-
 “ tineret diversas ordines literarum 24.”† An inconceivable number; being twenty three places of figures,

* Anton. de Solis Hist. de la Conquista de Mexico, page 71.

† Quoted by Mr. Harris from Tacquet's Arithmetic. See *Hermes* also upon the $\psi\lambda\eta$ or matter of Language, from page 316 to page 327.

figures, or upwards of 1480 TRILLIONS of pages; without attempting to calculate the great variety of changes upon each! Hence, from a few characters, words might be formed greatly surpassing the utmost expansion of human ideas.

Since, then, these few elements of words may, from time to time, involve new subjects of importance, as long as this world shall exist, should it not form a part of the business of all who can, however slenderly, assist therein, so to promote their improvement and regularity, that they might become in this, as they nearly are in some other countries, of a definite import? This would give to language that symmetry and stability by which it would be rendered intelligible, not only at one particular period, but also easy of access to after ages.

Yet if there be any who imagine that a thorough, philosophical knowledge of language may be obtained without an acquaintance with its elements, they might just as well attempt to descant upon colours without ever having had a perception of light.

Lord Monboddo, whose writings will afford pleasure and improvement to all who peruse them, says, with some point, though with that liberality which should ever accompany science, and which will always contribute no less towards cherishing its growth, than an indulgent criticism will towards the correction of those errors to which all men are more or less liable: "Though I myself think nothing
" trifling that belongs to so noble an art, (Lan-
T " (guage

“ guage) yet I well know that I do not live in such
 “ an age as that of Augustus Cæsar, when Messala,*
 “ a noble Roman, and the first orator of his time,
 “ wrote a book upon each letter of the alphabet,
 “ and Julius Cæsar, as it is well known, employed
 “ himself in writing upon another part of Gram-
 “ mar,† when he had upon his hands the most
 “ dangerous war in which he was ever engaged.”
 But “ the learned of this age,” his Lordship remarks
 with some poignant ridicule, “ though they be
 “ so much occupied with facts of natural history,
 “ minerals, plants, flies, and reptiles, that they
 “ have no time to apply to the history and philo-
 “ sophy of their own species; yet I should think
 “ that

* The History of the Origin and Progress of Language, vol. ii. page 239. Concerning Messala, vide Cicero. de Claris Oratoribus, sub finem. Horace and Tibullus make honorable mention of the same great orator, to whom the Ciris of Virgil is inscribed.

See also Suetonius in his Life of Claudius Cæsar, of whom he says: Novas etiam commentus est litteras tres, ac numero veterum quasi maxime necessarias addidit. De quarum ratione, cum privatus adhuc, volumen edidisset. Lib. v. cap. 41. And Tacitus takes notice of the same, in Annalium libri xi. capitibus 13 and 14. See likewise Justus Lipsius upon this subject.

† De analogia libros duos.—In transitu Alpium, as Suetonius relates. For they were his two books against Cato, which he wrote about the time of his battle at Munda, so unfortunate for the interests of Pompey.

“ that they would have some curiosity about an
 “ art so exceedingly useful, by which the busi-
 “ nefs of human life is carried on; by which
 “ arts and sciences have been conveyed from man
 “ to man, and from nation to nation, and from
 “ the earliest to the latest ages; and without which
 “ they could not have been instructed in the know-
 “ ledge they value so much: for how else could
 “ they profit by the most accurate account of
 “ insects, which Reaumur has given in six volumes
 “ in quarto, containing the history of flies with two
 “ wings, and flies with four wings, with a supple-
 “ ment to the history of flies with two wings; but
 “ which he very modestly intitles not a history,
 “ but only *Memoires pour servir à l'Histoire des insectes*.*”

In

* Advertisement prefixed to the third volume of the History of the Origin and progress of Language.

A Friend, who was present at the reading this paper, has since obliged me with the following transcript, as strongly pointing against those who are too confident in their instinctive knowledge and perfection, to imagine, that disquisitions upon such diminutive parts of Grammar can be of any importance:

“ I remember to have met with a passage in a certain
 “ Writer, which is not at all favourable to the Grammarians;
 ἔμοι πρὸς Φιλοσόφους ἐξί Φιλία· πρὸς μὲν τοι σοφιστὰς ἢ
 γραμματιστὰς ἢ τοιῶτο γένος ἕτερον ἀνθρώπων κακοδαιμόνων,
 ἅτε νῦν ἐξι Φιλία, μήτε ὕσερόν ποτε γένοιτο.

“ My friendship I bestow upon philosophers: As to
 “ Sophists, little grammarians, and such sort of scoundrels,

In another place, the same learned author observes:
 “ That all the works both of nature and of art are
 “ compounds, which the sense presents to the mind:
 “ these it is the business of science to analyze
 “ and resolve into their first principles, or con-
 “ stituent parts. The analysis of Language into its
 “ elemental sounds was no doubt a work, and
 “ a work of great art; and after that it was an
 “ ingenious thought to think of noting those ele-
 “ mental sounds by visible marks, and of speaking
 “ in that way to the eyes. Language is so commonly
 “ used, and of such facility in practice, that men
 “ who have not studied the art are apt to think
 “ that there is no art in it: on the other hand, men
 “ of curiosity, who are not satisfied with the practice,
 “ but want to know the reason of things, find great
 “ difficulty in explaining the nature of language,
 “ and giving a rational account even of the common
 “ parts of speech and of their various uses. But
 “ there is one satisfaction from the study of the
 “ works of art, and which to the lover of know-
 “ ledge

“ and ——— cacodæmons, I neither have, nor ever will
 “ have any regard for them.”

‘ The man abhors grammarians; and grammars, I suppose.
 ‘ But who is the author of this bit of Greek? An extra-
 ‘ ordinary person, I assure you; a projector, a visionnaire, a
 ‘ linguist by inspiration, a crack, a conjurer — in short
 ‘ Apollonius Tyanensis. He is the man; and the gram-
 ‘ marians account it no disgrace to be vilified by a mounte-
 ‘ bank.’ Jortin’s *Life of Erasmus*, Note, page 604.

‘ Vid. Apollon. Epist. prim. p. 385. Philostrat. Edit. Olear.’

“ ledge is an abundant recompense for the labour
“ it costs him, that we can get to the bottom in
“ such study, and discover the first principles of
“ the art; whereas in the works of God and nature,
“ there is a wisdom and contrivance of which we
“ cannot see the end; and, therefore, I doubt
“ whether in such matters, the human faculties can
“ ever attain to perfect science.”*

Indeed, the ultimate or smallest constituent particles of matter are so envelopped and hidden from human comprehension, that I know of nothing better whereby to express my ideas thereof than by believing it possible, that the GREAT INTELLIGENCE who formed this world as it is, could also form its likeness in miniature, and all that it contains of every kind whatever, within a space which might be filled by a particle so minute, that it should elude the finest search of microscopic enquiry wherewith, according to our present state, we are acquainted! not to believe this, would amount to an assertion, that matter could be annihilated merely by division—which would be an absurdity to suppose.

But, leaving reflections, so far abstracted from our present subject, the enquiries are, whether or not the English Alphabet be defective? And, if it be so, whether, as being the basis of the language, it would be either practicable, or desirable to regulate
it

* History of the Origin and Progress of Language, vol. ii. page 18 and 206.

it by that accurate and invariable method, which can be acquired only by a due attention to the analysis and synthesis of sounds? For this attention would perhaps be the root of greater improvement; inasmuch as sound and language should be the inseparable index of the sense; because, without accuracy therein, a just discrimination of ideas could not always take place; and certainly, as reason can best operate when the senses are all in unison, contrarieties should not be joined, where an individual truth is proposed. Words should therefore be analogous in principles, both as to sound and to appearance.* But, though I may say with Mr. Locke,† “that
 “ I am not vain enough to think that any one can
 “ pretend to attempt the perfect reforming the
 “ languages of the world, no not so much as of his
 “ own country, without rendering himself ridicu-
 “ lous,” yet something may be done at every opportunity to favour progressive improvement, rather than the corruption of language.

I am well aware that little offers in this matter to flatter our hopes with any early probability of
 amending

* “The Greeks had, in the whole structure of their
 “ language, a proper regard to the ear, as well as to the
 “ understanding; and employed the *whole* power of ele-
 “ mental sounds to make their language both soft and
 “ manly in the pronunciation.”

Origin and Progress of Language.

† On the Human Understanding. Book iii. Chap. 11.

amending the alphabetical characters of our country ; since prejudice and habit long connected, are sometimes inflexible opponents to the arguments of reason and utility. And, indeed, though the defects of our Alphabet should be universally acknowledged, yet its improvement, for reasons before mentioned, is scarcely to be expected in a period of many years. Nevertheless, why should any one of rational curiosity shrink wholly back and renounce the subject, as a matter either too perfect and too far privileged, or too mean and forlorn to challenge criticism or correction? It would consume some time to enumerate all, who at the present are known to have written upon this part of Grammar ; therefore passing over the names of Varro,* Lucian,† &c. we may take a survey nearer to our own time, and adduce some names of authority sufficient to vindicate the utility of the enquiry, as connected with every branch of learning. Such are Erasmus,|| Theodore

* Of Terentius Varro enough is extant to cause regret that no more of his works have escaped the ravages of Time and the vicissitudes of Fortune.

† Vide *Δίχην Φωνηέντων*, or *Σίγμα* versus *Ταϋ*. And also Jortin's Life of Erasmus. vol. ii. page 141.

|| The Dialogue by Erasmus is well worthy of perusal :

Dr. Jortin, in the second volume of his Life of Erasmus, page 96, particularly notices it ; saying, “ that these three
“ works

Theodore Beza, Ceratinus, Mekerchus, Lipsius,* &c. The following lines, which Mekerchus writes in his commentary concerning the ancient and true pronunciation of the Greek, are applicable to every language, and by defining what every language ought to possess, shew us how far ours is deficient :

“ Porro cuilibet Linguæ, ut facilè, statim, et rectè
 “ intelligatur, opus esse distinctâ, certâ, et inconfusâ
 “ singularum litterarum pronunciatione, ipsa ratio
 “ indicat, et clarius est quàm ut probari debeat.
 “ Quandoquidem extra controversiam est, singulas
 “ litteras et diphthongos inter se planè diversas esse,
 “ et, ut Fabius docet, proprium ac peculiarem
 “ habere sonum. Frustra enim distinctæ essent
 “ litteræ,

“ works (including his Colloquies and his *Ciceronianus*)
 “ will last for ever, and be for ever perused with pleasure
 “ by the most skilful and learned ; as long as any portion
 “ of literature and of good sense shall remain in the
 “ world.”

* Lipsius wrote his Dialogue “ De Recta Pronunciatione
 “ Latinæ Linguæ,” at the request of the illustrious Sir Philip Sydney, to whom it is dedicated, as to one, observes Lipsius, who might say of himself with more propriety than Archilochus did :

Ἐμὶ δ' ἐγὼ θεράπων μὲν ἐνυαλίῳ ἀνακτοῖ,
 Καὶ μουσέων ἐρατὸν δῶρον ἐπιζάμενος.”

Thus imitated :

Though I War's Monarch dutiful attend,
 Not less am I each Muse's grateful friend.

“ litteræ, si sono nihil differrent. Alioqui propter
 “ sonorum confusionem et similitudinem lingua
 “ scateret amphibologiis: nec posset commodè legi
 “ vel intelligi; ac loquenti simul et audienti nau-
 “ seam pareret.”

Those, however, who have not very assiduously examined the nature and formation of those simple sounds, of which words are constructed, would do well to pay some attention to a subject, which is as intimately connected with every thing elegant and liberal, as are the concealed foundations with the superstructure of the most beautiful piece of architecture. Now as the elemental sounds form the foundation, and in short the whole essence of language, perhaps nothing would contribute more to spread and perpetuate it, than a certain and distinct notation of its elements, or such marks, inscribed or superscribed, as should indicate the anomalies, to which some poor, solitary letters are, in our language, subjected.

Without doubt the existence of the Greek language for upwards of five and twenty centuries, without any great alteration, may be attributed, in part, to its precise orthography, as well as to the excellent genius of those writers, who made use of it.*

U

Though

* The variety of their dialects makes nothing against the regularity of their general pronunciation; for it seems certain, that they were all well acquainted with the exact powers of each letter; and, that they added, exchanged,
 or

Though, after all, it is to be confessed that the best languages have changed; some after having continued for many ages; others in periods comparatively short. And such, from a variety of unforeseen causes, will be the fate of all languages; being, like rivers, in motion; and, like these also, liable to the corruption and decay of their sources.*

So far being premised, and such competent authorities being brought in view to countenance the attempt, the remaining Section shall be allotted to the particular examination of the English Alphabet, and of the sounds it ought to represent; with a view to prove where it is misused, and to shew where it might

or expunged, according to the custom of their dialects, but it is not to be supposed that such accurate people gave, as we do, a number of sounds to any individual letter; in this respect, the greatest liberty they seem to have taken was that of occasionally pronouncing a short vowel as a long one, or the contrary (as instanced by Martial, lib. 9. epig. xi. Edit. Scriverij.) through a licence assumed by their poets,

Et quos ἄρες ἄρες decet sonare;

alluding to that verse, which occurs twice in the Iliad:

Ἄρες, Ἄρες, ἑροτολοιγέ, μικιφόνε, ταχέσιπλήτα.

Where, however, the difference of the accent, placed over the first word, seems a strong support of Dr. Clarke's opinion, that there is a crasis of $\tilde{\omega}$ in the first syllable, for $\tilde{\omega}$ Ἄρες.

* "Consuetudo loquendi est in motu; itaque solet fieri
"ex meliore deterior, &c." Ter. Varr. De Ling. Lat.
Lib. viii.

might be amended ; yet without presuming to offer any thing of my own, as a perfect model for imitation ; but only as hints, which others may improve upon.

SECTION II.

A SIMPLE letter, or element, is thus concisely distinguished, in the following words from Diogenes Laertius : *τριχῶς δὲ λέγεται τὸ γράμμα· ὁ τε χαρακτὴρ, τὸ σοιχείον, καὶ τὸ ὄνομα, ὅιον α.*† This includes

† In Zenonem. Lib. vii. page 471. Edit. Hen. Steph. I have here ventured to alter this passage, which, in the above édition, is printed, *ὁ, τε χαρακτὴρ τῷ σοιχείου καὶ τὸ ὄνομα.* where *ὁ χαρακτὴρ τῷ σοιχείῳ*, thus joined, signifies only one thing, that is, the *form* of the letter ; *τὸ ὄνομα* another, which is the technical name of the letter. Therefore it seems an error to say *τριχῶς δὲ λέγεται*, when it appears only *διπλῇ λέγεσθαι*. The error might have easily originated with some transcriber, who having mistaken the *υ* for an *υ*, might have changed the accent and omitted the comma after *χαρακτὴρ*.

I am aware that this may be proceeding too far ; nevertheless it is true, what an eminent writer asserts, that

includes three accidents in every letter; namely its written form, whereby it is recognised by the sight; its elemental or simple sound, by which it reaches the mind, by means of the hearing; and its technical or memorial name, which should not, however, exceed the length of one syllable; saying rather simply, *α*, than *αλφα*; in order to avoid the commixture of heterogeneous sounds with the simple, elementary parts of words, which, in some languages, are so often heavily and unnaturally incumbered. For what affinity have the intermediate letters of *αλφα* with the word, *ἁρμονικός*, unless, as it appears, it was so named to distinguish the vowel in its double capacity of being long and broad, by its first, and short and more slender, by its latter position? In naming the letters, as, a; be; ce; &c. the modern languages seem to have the superiority.* While the

“ nothing hath more contributed to bring literature into
 “ contempt, than the custom, which the Wits and the
 “ fine Geniuses, real or pretended, have taken up to con-
 “ demn as school-learning and pedantry, citations from
 “ Greek and Latin authors, and philological remarks.”

* Mr. Sheridan, in his very excellent Rhetorical Grammar, has judiciously prefixed the vowel to all the letters, by which method of pronunciation they can best coalesce with their adjoining letters. Indeed, his Grammar abounds with such a copious explanation of the principles of the English Language, that having consulted it only since the commencement of this Essay, I have much contracted my original plan.

the Ancients have Aleph, Beth, Gimel, &c. Alpha, Beta, Gamma, &c. and of three syllables, as *ιωτα*. and there are letters, at this time in use, named with three syllables.

The characters which are, at present, made use of, to express every sound in the English language, are in number twenty six. These are well known; and, as the vowels are held to be the first of all human sounds, and consequently the most simple; it seems fit that they should be considered before the consonants, or secondary letters.

Archelaus, the master of Socrates, was, we are informed, the first who taught that the origin of the voice was a percussion of the air.* And it is
the

* *Πρῶτος δὲ εἶπε Φωνῆς γένεσιν τὴν τᾷ ἀέρος πλήξιν.*

Diog. Laert. Lib. ii. in Archelaum.

And Aristotle, moreover, where he writes *περὶ Φωνῆς τῶν ζώων*, makes these distinctions: *Φωνὴ δὲ, καὶ ψόφος ἕτερόν ἐστι· καὶ τρίτον τούτων διάλεκτος. Φωνᾷ μὲν οὖν οὐδενὶ τῶν ἄλλων μορίων οὐδὲν, πλὴν τῷ φάρυγι. διὸ ὅσα μὴ ἔχει πνεύμονα οὐδὲν φθέγγεται. Διάλεκτος δὲ, ἢ τῆς Φωνῆς ἐστὶ τῇ γλώττῃ διάσθρωσις, τὰ μὲν οὖν Φωνήεντα, ἢ Φωνὴ καὶ ὁ λάρυγξ ἀφίησιν· ὅσα δὲ ἀφωνα ἢ γλωττία καὶ χάλη· ἐξ ὧν ἢ διάλεκτός ἐστι.*

Aristot. de Hist. Animal. L. iv. cap. 9.

Aristotle herein agrees, in most respects, with his predecessor, Hippocrates, the whole of whose theory of the voice was too
long

the most simple and equal percussion, during particular dilations and contractions of the cavities of the mouth, regulated by the tongue, (but the lips by no means coming in close contact, as they must in forming many consonants) which constitutes the vowels. From this, the following axioms may be deduced:

First; that sound, propelled during any one, uniform position of the organs of speech, must uniformly be of the same species: thus, in pronouncing A, which, sounded as in war, is the deepest and most open vowel we have, the element is the same, whether it be sounded by a whisper, or by the loudest voice. It is, therefore, this one, simple

long to be transcribed as a note, and perhaps it would not be equally interesting to every one to read; but the following short relation will shew how attentive those ancients were to trace effects to their causes (even sometimes by means of the very accidents, interrupting their regular economy) and thus to enlarge the history of human nature: *Ἰδὸν δὲ ἤδη οἱ σφάξαντες ἐωϋτὲς, ἀπέταμνον τὸν Φάρυγγα παντάπασιν. ἔτοι ζῶσι μὲν, Φθέγγονται δὲ ἑδὲν, εἰ μὴ τις συλλάβῃ τὸν Φάρυγγα· ἔτοι δὲ Φθέγγονται. δῆλον δὲ καὶ τῆτο, ὅτι τὸ πνεῦμα ἔδύναται διὰ τετμημένε τῷ λάρυγγος ἔλκειν ἔσω ἐς τὰ κοῖλα, ἀλλὰ κατὰ τὸ διατετμημένον ἐκπνέει. οὕτως ἔχει περὶ Φωνῆς ἵτως καὶ διὰ λέξεως.*

Hippoc. περὶ σκερῶν Edit. Foëfij.

simple found, from a mere opening of the mouth, which creates a vowel.


Secondly; should any one draw a right-line through a given space, and instantaneously glance off, and continue the line in another direction, it would no longer be a simple right-line; it would be two contiguous right-lines; and the result would be some sort of angle.

And, thus, if any other position should follow, with whatever velocity, and during the instant of pronouncing any certain vowel, give thereto a different tendence or inflection, the found produced would not be a simple found; therefore, not a mere vowel; it would be a compound of two vowels; and therefore a diphthong.*

Such is our letter I, as pronounced in *clime*, *time*, &c. for it is a compound of two vowels; the first of which cannot be exactly expressed, but by the short found of the open A, or of the O in Joy—the second has the true found of the continental I, or
English

* “Diphthongus ita solet definiri à Grammaticis, ut sit
“syllaba ex duabus vocalibus conflata sonum retinentibus.
“Ego verò malim dicere, In *unam mixtam vocem* coeun-
“tibus (nam alioquin quando distinctæ sunt vocalium
“voces, duæ syllabæ nascantur necesse est) aut hoc certè
“addiderim definitioni, Quæ raptim et uno spiritu pro-
“ferri possunt.”

Beza De Veteri et Germ. Pron. Græc. Ling.

English E E. thus: O  I. blended into oi or ai.*

The following words are nearly pronounced with the above, I: Quoif, Quoin, Quoit. I am the more particular upon this character, because, though it is, by some, justly considered as a diphthong in such words as *twine*, *combine*; and as a vowel in such as *win*, *thin*, &c. yet there are many who will contend, that it is in all cases a vowel—because it so appears in writing.† But let any one pronounce this letter, slowly, and he will soon perceive the difference, between the first and latter part of it; he

* *AI (Græcorum) non dubium est quin Latinorum ai respondeat, raptim scilicet & uno spiritu pronunciato, ut post æ non respiret, ne duæ syllabæ pro una audiantur.*

Beza de Veter. et Germ. Pron. Græc. Ling.

† It appears, from Grammars published abroad for teaching the English language, that Foreigners have, in a great degree, better analysed our alphabetical sounds than in general we ourselves have, whose peculiar business it ought to be to do so. And, thus, M. De Lolme anticipated the account of the British Constitution—"of that happy land," as he says, "where LIBERTY had, at last, been able to erect herself a Temple." A Temple, which none could defile without a tear—for its rites are the dictates of Benevolence, and its truest Guardians are Peace and Concord, who will never shut its gates against the meritorious and unassuming votaries, the fraternal competitors of Freedom and Happiness.

"The

he will, moreover, be sensible of the varied position of the tongue, during the latter part of the sound; but if his ear will not suffer him to make this distinction, let him press upon the tongue with the whole length of a finger, and, at the same instant, let him attempt to sound the long I, as it is sometimes called. One half of this sound he will pronounce very readily; and it will be as, or nearly as, a short open A or O. The latter moiety of the sound will be as the I in *field*: And he will be convinced, in completing the sound, that though the first part thereof can be formed without interruption from the finger, yet the tongue will strongly resist and raise the finger towards the palate, in forming the remaining portion of the diphthong.

Dr. Johnson says of I, "that it has a long sound
" as in *fine*; and a short one, as in *fin*; and that
" it is eminently observable in *i*, which may be
" observed in other letters, that the short sound

X

is

"The English," observes one of the Grammarians alluded to, "have six vowels, which have a twofold pronunciation, that is to say, long and short, as:

a when long, is like	ah	In the Ger. lang.	when it is short, like	a	In the Ger. lang.
e	-	ih	-	e	i
i	-	ei	-	i	e
o	-	oh	-	o	o
u	-	ju	-	u	u
y sometimes like	ey		sometimes like	i.	

" is not the long found contracted, but a found
 " wholly different."*

This is certainly true in part: why therefore use only one character for two sounds, *wholly different*? If Dr. Johnson had resolved the found into its principles, he would have been enabled to give a much more precise and satisfactory account of this letter. But indeed, this excellent and ingenious Author had been so much accustomed to the more delightful parts of Grammar—to the composition of works, which will bear the test of ages; that he seemed to forget that the language of science, and the most beautiful lessons of morality cannot be transmitted to posterity, without the aid of letters, included in words; and, therefore, he has treated of this part of Grammar too fastidiously, and consequently, in some respects, erroneously. He has done much towards establishing a standard of words, for such as know how to use them; without doing enough for the true distinction of syllables, by which the language would be acquired by children in half the usual time, and be of easy access to foreigners desirous of learning it, from whom it is, generally, long withheld by numerous impediments. And moreover, he is rather
 too

* Dr. Jortin, speaking of the modern Greek pronunciation, in his Life of Erasmus, vol. ii. page 140, says something like this: that "they pronounce the *l*, not " broad, as we English do in *templi*; but softer, as we do " in *templis*."

too severe upon all, who would attempt the complete examination of what he, nevertheless, confesses to have taken “ from other Grammarians, perhaps with more reverence than judgment.”

It is but fair, in this place, to state Dr. Johnson’s words, which, however, do not argue against an investigation of this subject; for the long establishment of perverse habits in forming words, prove nothing against the preexistence of an immutable essence, in respect to their elements:

“ There have been many schemes offered for the emendation and settlement of our orthography, which, like that of other nations, being formed by chance, or according to the fancy* of the earliest writers in rude ages, was at first very various and uncertain, and is yet sufficiently irregular. Of these reformers some have endeavoured to accommodate orthography better to the pronunciation, without considering that this is to measure by a shadow, to take that for a model or standard which is changing while they

X 2

“ apply

* Chance and Fancy may very properly form symbols of sounds at any period of the world; but it is most certain, that neither Chance nor Fancy ought to be concerned in their application and uses, which should be fixed by Reason, and, when so fixed, should be permanent. The *form* of alphabetical characters is of the least importance, though the varieties and neatness in this respect contribute to our pleasures: the form of a letter is not its essence, any more than body is spirit.

“ apply it.* Others, less absurdly indeed, but
 “ with equal unlikelihood of success, have endeavoured
 “ to proportion the number of letters to
 “ that of sounds, that every sound may have its
 “ own character, and every character a single
 “ sound. Such would be the orthography of a
 “ new language, to be formed by a synod of grammarians
 “ upon principles of science. But who
 “ can hope to prevail on nations to change their
 “ practice, and make all their old books useless?
 “ or what advantage would a new orthography
 “ procure equivalent to the confusion and perplexity
 “ of such an alteration?

“ Some of these schemes I shall however exhibit,
 “ which may be used according to the diversities
 “ of genius, as a guide to reformers, or terror
 “ to innovators.”†

Can any thing be more inconsistent, than when he lays it down that, “ for pronunciation the best
 “ general rule is, to consider those as the most
 “ elegant speakers who deviate least from the
 “ written words”? How will any person, not acquainted with the language, be able to pronounce, for example, the words *condign*, *subtle*,
 any

* “ But supposing a language to have acquired its utmost
 “ perfection, I see nothing that should necessarily occasion
 “ any change.” Sketches of the Hist. of Man, vol. i. p. 162.

† Dr. Johnson then gives specimens of orthography, recommended severally by Sir Thomas Smith; Dr. Gill; Charles Butler; and Bishop Wilson; which are all sufficiently fanciful, and wanting in that simplicity and accuracy, which every alphabet ought to possess.

and others of the same kind? The knowledge of any learned language will be no assistance in this respect; for in the Latin, the words are *condignus*, *subtilis*, &c. Italian, or French would bring him something nearer: but to arrive at the knowledge of the vernacular pronunciation, he must be initiated into the mysteries of the language; and then he will find that the G and B are in no degree founded. The words *jail* and *jailer* are as often written *gaol* and *gaoler*. Shall they, therefore, be pronounced *ga-ol* and *ga-oler*?† To assert, that the pronunciation is most elegant, which deviates least from the written words, would be to suppose, that our alphabet is, like the alphabets of the Greek, Latin, Italian, and some other languages, of an uniform pronunciation. But so far, on the contrary, is the capriciousness of our language, that Mr. Sheridan reckons upwards of seventy different ways, which constantly occur, for characterizing only *nine* of our vowel sounds!* Moreover, for expressing about
thirteen,

* They who could wish to be well acquainted with the analysis of the English Language, and the great variety of modes of expressing even the simple sounds, would find ample information in an attentive perusal of the Rhetorical Grammar, before mentioned.

† In Bell's Edition of that beautiful piece of Philosophy, Pope's "Essay on Man," Epist. ii. v. 237, the word *goal*, by no uncommon mistake, is printed thus:

"Each individual seeks a sev'ral *gaol*;

"But Heav'n's great view is one, and that the whole."

Here

thirteen, different, simple vowel-sounds, there are no more than seven characters; which are applied in all cases, without any kind of point for distinction. Whilst the Germans, without incumbering their words with many useless letters, have, by small marks, nicely distinguished all the varieties of vowels used in their language. So that whoever shall have been once taught the genuine sound of their letters, will find no insuperable difficulty in reading their language.† And certainly particular marks, for
the

Here the sound of one ending depends not upon its own intrinsic form, as it ought to do, but upon the rhyme of the next line. Now if any person of a future age were to read the above passage, and be obstinate in pronouncing the first ending — *jail*, he, on his part, might say, perhaps, that the word, which should chime thereto, was wrong; and, that it ought to be *whale*: however, without such correction, it would be as fine nonsense, in blank verse; for it could not be supposed that each individual merits imprisonment: and the visitation of prisons is too rare a virtue for all men to put in practice, however inclined they might be to imitate the examples of a Howard.

† The author of an excellent little “Essay on Punctuation,”* appears no friend to such a method of defining the sound of words; but censures the French language, and not altogether without cause, on account of the multitude of its accents; adding, “that our language has happily escaped this horrid incumbrance, and preserved a beautiful simplicity.” It may be worthy of notice, that law manuscripts are seldom encumbered by what this gentleman has so successfully written upon, Punctuation;
here,

the different modifications of language, are as necessary as for directing the various modulations of musical

here, therefore, in some views, the language may be thought more beautifully simplified, and more nearly resembling modes of the first antiquity; though it can hardly be doubted, but it must, in some instances, barter perspicuity for such simplicity.

It is certain, that the French are obliged to use a great concourse of accentual marks; having only six characters to express all their varieties of vowel sounds. Perhaps, these deficiencies, among other motives, might have induced Erasmus to call it, "*Lingua barbara et abnormis, quæ aliud scribit quam sonat, quæque suos habet stridores et voces, vix humanas.*"

It would be better, however, to abate a little of the severity, on the one side, and a little of the too warm encomium on the other; and then it will be allowed, that the use of our alphabet, though not as absurd as that of the French language, is, nevertheless, defective in many instances. Though there may be many, who, at first sight, will not allow that it is so. For, under the various states of this short life, which, in so many ways modify the human heart; difference of opinion, whether concerning things temporal or spiritual; things beneath human notice, or superior to its highest wisdom, will ever be as much man's leading characteristic, as difference of feature and complexion: he, therefore, who, upon all occasions, can shew the greatest candour, towards the *inoffensive* bias of man, and the venial errors of opinion, will afford a comparative indication of his progress in the knowledge of the mind: mutual concessions are necessary to mutual improvement; this truth may be proved by experience, and all men, by turns, may stand in need of, and enjoy its advantages.

musical sounds: A, *flat*, differs from A, *natural*, and is, therefore, properly distinguished by a certain mark, *b.* but, were such note in the key, and no mark added, he must possess a musician's skill and quickness of musical apprehension, who, in playing such apparent note, would not, at first, mistake the key, and produce a dissonance. A well practised musician might also, it is true, in a certain degree, so accommodate an ill tuned violin, that by his skill he should produce some melody therefrom; though it is certain, that he could much better, and more agreeably, manage an instrument, whose tones were well adjusted: for example, intending to produce the tone, B, he might shift his finger to that part of the string, which, if it were in tune, might possibly appear a note or two above or below that position; so, not having a well marked alphabet, we occasionally turn â into "a or e; e into ie; I into OI or AI; O into A; and U into the diphthong IU or Russian IO, and also into the Hebrew kibbutz.

Concerning the vowel, Y, Dr. Johnson, in two places of his grammar, gives the two following, contradictory accounts, only one of which can be true:

1st. "Y, is a vowel, which, as Quintilian observes of one of the Roman letters, we might want without inconvenience, but that we have it. Y being the Saxon vowel *ȳ*, which was commonly used where *i* is now put, occurs very frequently in all old books."

2dly. "Y,

2dly. "Y, when it follows a consonant, is a vowel; when it precedes either vowel or diphthong, is a *consonant*, as *ye, young*. It is thought by some to be in all cases a vowel. But it may be observed of *y* as of *w*,* that it follows a vowel without any hiatus, as *rosy youth*."

Perhaps he did not consider that, like colours and musical notes, the sounds of language may break

Y
off

* A similar discordant account of *W* is also given by the same author: "for *u*," he says, "we often write *w* after a vowel, to make a diphthong; as *view*, &c." But how make a diphthong from a vowel and a consonant, which in another part of his Grammar he seems to think that *w* is? As: "of *w*, which in diphthongs is often an *undoubted* vowel, some Grammarians have doubted whether it ever be a consonant; and rather as it is called a double *u* or *ou*, as *water* may be resolved into *ouater*;—but letters of the same sound are always reckoned consonants in other Alphabets: and it may be observed, that *w* follows a vowel without any hiatus or difficulty of utterance, as *frosty Winter*." It follows, therefore, that *U* in the Latin, Spanish, and Italian; and *ou* the French adverb, have hitherto been mis-named; being all of nearly the same sound—and therefore Consonants! In the German Alphabet, indeed, the *w* is called *veigh*, and sounds sometimes like a weak English *v*; but mostly as our *w*. The two vowels of the word *root*, and of several other words with the same vowels, have the sound of the true and simple *U* or *W*; but if any one should pronounce the words *blood* and *flood* in this manner, a dialect of such rusticity would provoke the mirth of an auditory; so far does custom, in some cases, pervert the more general analogy of vocal symbols.

abruptly; may be in contact as it were; or may so coalesce together that each of these predicaments shall possess a sensible difference. A red and a blue colour, for instance, may be placed so near to each other as to appear in contact, without really being so; two musical notes may be played or sung in that distinct manner, which the Italians term *spiccato* or *spezzato*; or two vowels may be pronounced with a comma between them, and each of these modifications may be considered as a *hiatus*. Two colours, also, as well as two musical notes, or two vowels, may so closely approach, as to leave no interval of space or time between each other, and yet may be perfectly defined; but should the union be so intimate, that commixture should take place, a purple would be the result of those two colours. And as in music, when that, which is called a note *de Goût*, or grace, is softened, as it were, without the smallest interval, into the principal note (which it either precedes or follows) in such a manner, that
the

* “Nonnulli effectum fuisse volunt characterem Y,
“vero ad basin literæ u vocalis adjecto.”

Beza de Germ. Pron. Græc. Ling.

But how then could it be esteemed as a simple vowel, when composed of two vowels? It is as reasonable to suppose that the modern sound of the English y was taken from the Greek diphthong *y* which is exactly of the same sound as the French affirmative *oui*, and many other of their words, ending in *ui*, whether a consonant follow or not. But according to the English technical name, it is a triphthong, *ouai* or *uai*.

the union of the two can scarcely be distinguished, so exactly parallel is the union of two vowels: and I is like the note *de goût* to the O, in medallion and words of similar termination: as it is also, audibly, though not visibly, to U, when sounded as in *mute*. In the Russian Alphabet, the sound is well expressed by one type FO. Many other examples of diphthongs might here be noticed; but, as they are all resolvable by the same criteria,* it may be proper to pass on to the simple vowels, the number of which appears to be naturally seven; for so many principal variations may be formed, beside their diminutions, without bringing the lips into close contact with each other: and this number perhaps almost all human beings are capable of forming.† And, however novel it may seem, I am led to believe that the vowel sounds have nearly the same analogy to the primitive notes of Music, as these have to the primary colours; and the other varieties of the vowel sounds can only be esteemed,

Y 2

as

* On the contrary a vowel, or any simple letter, admits of no further analysis, but is, as Aristotle|| asserts, *Φωνὴ ἀδιαίρετος*,

† Οἱ ἄνθρωποι Φωνὴν μὲν τὴν αὐτὴν ἀΦιᾶσι διάλεκτον δὲ οὐ τὴν αὐτὴν.

Aristot. de Hist. Animalium, L. iv. c. 9.

|| See Winstanley's Edition of Aristotle's Poetics, page 64.

as in the same order as the chromaticks of Music and Painting:

“ for Nature opens

“ Proportions musical in all her parts.”*

“ The proportional breadth of the primary or
 “ prismatick colours, in the order as they are seen
 “ in the rainbow, is as follows: and answers to the
 “ musical notes opposed to each colour.

Red	45	}	Ut	}	§	E as in Fate.
Orange	27		Si		§	U — in shut.
Yellow	48		La		§	U — in Ruby.
Green	60		Sol		§	O — in Mote.
Blue	60		Fa		§	A — in Father.
Indigo	40		Mi		§	I — in Shield.
Violet	80		Re.”		§	A — in Wall.

I thought that this parallel could not be better exemplified than by the Hebrew system of vowels, which in some respects is certainly superior to any other in use; not even excepting that of the German vowels, which is very discriminate. For in the pointed Hebrew there is always a certain quantity in the syllables; and whoever understands the points can make few or no mistakes in the reading,

* See EUDOSIA, a Poem on the Universe, Book V. v. 480. by Capel Lofft, Esq.—see also the note upon the same verse; which comprehends the comparison of colours with the notes of Music. And with these I have endeavoured to parallel the primary vowels.

reading, as far as is at present known of a language no longer spoken. And even where the Hebrew does change its vowels, accordingly as the inflection and regimen of words may require, there are established rules, whereby to proceed. And those, who will not allow the vowel points to have been a part of the language before the Christian æra, will at least confess, that they were, whatever was the time of their invention, an effort of great genius and nice distinction;* since, in this system, there are all the most useful varieties of vowel sounds; and, in point of proportion, as it were, a diatonic and chromatic scale: For the primitive vowels are seven, and the simple variations are exactly five, beside the sheva quiescent, which is as our E mute: and this agrees nearly with the nature of musical notes.†

Thus

* Beza says: “Puncta vocalia ab Hebræis Grammaticis, divinissimo certè invento excogitata.” Indeed what is there to contradict the opinion, that the whole Alphabet might have been of divine origin? Was it not as easy for the ALMIGHTY to give MOSES an Alphabet, as to give him the Decalogue?

The Rev. Gilbert Wakefield observes, “that all the sagacity and experience of succeeding generations, illustrated as they have been by a vast influx of additional knowledge, beyond the most accomplished of their predecessors, have been unable to superinduce any real improvement upon the *Hebrew* alphabet.” On the Origin of Alphabetical Characters. See 2d. vol. of these Memoirs, p. 296.

† “Le Genre *diatonique* est celui de trois qui procède par tons et demi-tons majeurs, selon la division naturelle de la Gamme,” Dictionnaire de Musique par M. Rousseau.

Again:

Thus the following seven seem to be the primary or fullest vowels :









and the variations are these five very short vowels,
which

Again : " Le Genre chromatique de Musique est celui qui
" procède par plusieurs semi-tons consecutifs. Ce mot viens
" du Grec *χρῶμα*, qui signifie *couleur*, soit parceque les
" Grecs marquoient ce genre par des caractères rouges, ou
" diversément colorés; soit, disent les Auteurs, parceque
" le genre *chromatique* est moyen entre les deux autres,
" comme la couleur est moyenne entre le blanc et le noir;
" ou, selon d' autres, parce que ce genre varie et embellit
" le Diatonique par ses demi-tons, qui font, dans la musique
" le même effet que la variété des couleurs fait dans la
" peinture." Ibid.

There are very few, I am persuaded, who will misunderstand this theory as a supposition, that the vowels, in common speech, are musical notes, any more than the primitive colours are such: since musical notes depend upon the more extensive powers of the *larynx* and *epiglottis*, this serving to the former as the fingers do in performing on the flute, to vary its aperture, and thence consequently to increase or diminish the moment of any one given quantity of air propelled through such varied aperture, and thus producing intonation. § But the vowels have





§ Hippocrates, in his first book *περὶ διαίτης*, says that the tongue imitates music (*γλῶσσα μουσικὴν μιμῆσται*) whereas the tongue does not seem necessary to forming tones. One of its principal uses is the articulation of speech.

which cannot be accurately pronounced unless they be joined with their consonants :

^{12.} 
^{11.} 
^{10.} 
^{9.} 
^{8.} 
 — Besides the sheva, ^{13.} 

All which sounds are contained in the following words, under corresponding numbers :

¹ War, ² car, ³ tete, ⁴ field, ⁵ vote, ⁶ rule, ⁷ nut, ⁹ ⁸ allot,
 ¹¹ ¹⁰ effect, ¹² ¹³ written.

Beside these simple vowels, the Hebrew has also diphthongs, as well as other languages: such as   the future of  , he spoke, and many others.

So much for the Vowels; which, with their varieties, are thus shortly proved to be in their most simple state, TWELVE or THIRTEEN—all of which are constantly used in the English language; and yet we have only seven characters, without any distinctive marks, occasionally added, to represent them in writing; and even two of the

have that breadth or density of sound, which may be exemplified on any monochord, or on the frets of a Guitar, by a view of the proportionate distances and places of the notes considered abstractedly from sound, as is the corresponding breadth of the prismatic colours.

the seven, I, and Y, are equivalent ; the former whereof, and likewise U, are made to serve as often for diphthongs as for vowels.*

Now, as to the consonants, I shall be as concise as the subject will permit ; not dwelling unnecessarily upon such as always preserve their genuine and individual properties ; but making upon each such few remarks, as appear to have escaped the attention of others.

A SCHEME of the English Alphabet is hereto subjoined, wherein all the simple sounds are enumerated, and collated with those of the learned and some of the principal modern languages ; that is, however, as far only as is at present known of the pronunciation of languages, no longer spoken
by

* So indefinite is the knowledge, which children generally acquire, concerning the uses and exceptions of the English Alphabet, that it cannot be reasonably expected, that they should be able of themselves to read every common word, with sufficient exactness, although they might have been instructed for some months. On the contrary, in frequent instances, they require the constant collateral aid of tradition, as if their business were to be initiated into the mysteries of so many hieroglyphics, which had no affinity to the alphabet they had been taught. Now as children may be supposed in general to possess a similar capacity, in most places, it would be a subject of curiosity to inquire in what countries, at what ages, and under whatever other comparative circumstances the greatest number of children acquire the best and speediest knowledge of reading and writing their native language.

Scheme of Alphabets,

ARRANGED ACCORDING TO THE VARIETY OF SIMPLE CONSONANTS IN EACH.

(F. 136 Page 177.)

ENGLISH.		HEBREW.		SPANISH.		GERMAN.		ITALIAN.		GREEK.		LATIN.		FRENCH.	
Form.	Sound.	Form.	Sound.	Form.	Sound.	Form.	Sound.	Form.	Sound.	Form.	Sound.	Form.	Sound.	Form.	Sound.
A		א		A		A		A		A		A		A	
B	eb	ב	eb	B	eb	B	eb	B	eb	B	eb	B	eb	B	eb
C	ec	כ	ec	C	ec	C	ec	C	{ ec	Γ	eg	C	ec	C	ec
D	ed	ד	ed	D	ed	D	ed	D	{ etch	Δ	ed	D	ed	D	ed
E		ה		E		E		E	ed	E		E		E	
F	ef	ו	ev	E	ef	F	ef	E		Z	ez	F	ef	F	ef
G	eg, eg*, egz*	ג	eg	G	eg, egz*	G	eg, egz*	F	ef	H		G	eg	G	eg
H	etch	ח	et	H	et	H	eg, egz*	G	eg	Θ	eth	H		H	
I		י		I		I		H		I		I		I	
J	edge	י*	ez	I	ch	J	like z	I	el	K	ek	L	el	J	
K		כ	em	J		K		L	em	L	el	M	em	K	
L	el	ל	en	LL	em	L	el	M	en	M	em	N	en	L	em
M	em	מ	en	M	em	N	en	N	em	Ξ	en	O	en	M	em
N	en	נ	en	N	en	O	en	O	en	Π	ep	P	ep	N	en
O		ו		N		P		P		Ρ	er	Q	ep	P	ep
P	ep	פ	ek	Q	er	Q	er	R	er	Σ	es	R	er	Q	er
Q	et	ק	er	R	er	R	er	S	es	Τ	et	S	es	R	er
R	et	ר	eth	S	et	S	et	T	et	Υ	et	T	et	S	es
S	{ eth	ש	eth	T	et	T	et	U	et	Φ	eph	U	ev	T	et
T	{ eth	ת	eth	U	ev	U	ev	V	et	Χ	ez	V	ev	U	ev
U	{ eth	י	eth	V	ev	V	ev	W	et	Ω		X		V	ev
V	{ eth	ו	eth	W	et	W	et	X	et			Y		X	
W	edth	ו*	eth	X	et	X	et	Y	et			Z	ez	Y	
X	ev	ז	eth	Y	et	Y	et	Z	et					Z	ez
Y				Z		Z									
Z	ez														
Simple Conf. Vowels		17		17		17		16		15		15		15	

by a whole nation. For at this time, in different countries, there is a great diversity of opinions, respecting their pronunciation; people, in each place, adapting their own domestic accents to Languages, originating many centuries back, and at the distance of many hundred miles.

Z

Now

References to the opposite Table.

* All the Characters which are marked with an asterisk, have, in sound, some analogy to each other; therefore, whoever is acquainted with one or two of them, will not be very far off the sound of the others; but the χ , which is added to the Spanish and German G, does not sufficiently express the true sound, which ought to be heard, previous to imitation: indeed all explanation of alphabetical sounds depends upon a continual chain of references from language to language, and from one analogy to another.

† Th, gh, ch, sh, th, are all improperly and unnecessarily used as symbols of simple sounds.

‡ The termination. *ng*, (which may follow any vowel, as *ang*, *eng*, *ing*, *ong*, *ung*, and *yng*) being neither a complete *n* nor a complete *g*, but a kind of nasal sound between the two, it may therefore be added; and the simple consonants will then be twenty-one. For more particulars concerning this character, see the latter note upon *G*.; and also Mr. Sheridan's *Rhetorical Grammar*.—The sound of *ŷ* is not well known, and therefore omitted.

Now supposing, that all the thirteen vowels and variations were used in each of the above alphabets, yet still the English would preserve the balance of variety. And from those simple sounds are formed all the double sounding consonants of the languages enumerated; single characters having been used by way of abbreviating compound sounds.*

“ Quum enim inventæ sint literæ simplicibus sonis
 “ significandis, necesse est profectò *in omni lingua,*
 “ ut quidem commodè scribi possit, *totidem omnino*
 “ *litteras extare, quot sunt ejus soni simplices.* Alio-
 “ quin sive plures sive pauciores fuerint, et scrip-
 “ tioni et pronuntiationi *magnas tenebras offundi necesse*
 “ *fuerit.* Idque sollicitè Græcos observasse, vel hoc
 “ unum satis ostendit. quòd inter Elenchos Aris-
 “ toteles nullam *ex literis fallacem conclusionem*
 “ numerat: quum nihil possit frequentius occur-
 “ rere, si *uni literæ duplicem sonum,* vel contra *uni sono*
 “ *duas litteras tribueris.*

“ Simples igitur Græcæ linguæ sonos sexdecim,
 “ totidémque necessarias litteras esse, ex eo apparet,
 “ quòd ex reliquis octo qui totidem literis scri-
 “ buntur,

* Perhaps there are more simple sounds attributed above to the Greek than really belong to it: for the Z was formed, it is believed, of ds, and is rather to be compared to the Hebrew ז or German rz, than to the s, which, in the English, and when single, in other modern languages, is certainly a simple sound, differing from s. The simple sounds of the Greek were anciently accounted only sixteen, including five vowels.

“ buntur, alii sint compositi, alii suapte natura
 “ iidem cum compositis.

“ Sexdecim igitur antiquæ Cadmi literæ ex
 “ Phœnicia in Græciam illatæ, et totidem sonis
 “ simplicibus exprimendis repertæ, sunt hæ, α, ε,
 “ γ, δ, ε, ι, κ, λ, μ, ν, ο, π, ρ, σ, τ, υ. Nam aliæ
 “ præterea octo illis additæ sunt partim à Palamede,
 “ partim à Simonide, videcilet η, ω, ζ, ξ, ψ, θ,
 “ φ, χ; quod nulla quidem necessitate factum est,
 “ sed maximo tamen cum fructu, ut scriptio minus
 “ esset laboriosa, magisque compendiosa.”*

Now the consonants in the preceding number of Cadmean letters are only eleven; but as ζ, θ, φ, χ, though aspirated, are not double, according to the present pronunciation, each being easily founded, during one particular conformation of the organs of speech, by one simple contemporary energy of the breath; hence it is evident that the simple sounds may be reasonably accounted FIFTEEN.

In the German Language there are upwards of two hundred words beginning with *pf*, which character is truly of two letters; the sound of each being distinctly heard, as: *Pferd, pflicht, &c.*— This, however, even should it really be the genuine sound of φ, does in no wise lessen the number of simple sounds in the Greek: for allowing that

Z 2

one

* Adolph. Mekerch. Commentar. de Veteri et Restâ Pronunciatione Græcæ Linguæ, page 50. copied from Beza de Germana Pronunciatione Græcæ Linguæ, page 3 & 4.

one half of it, that is to say *f*, be a simple sound, this the ϕ has, as well as all the languages enumerated.

How far the English outnumbers those languages in variety of simple sounds, I have already endeavoured to shew: it remains next, however, to enter into a more particular enquiry concerning each, and this shall be done in the order of the foregoing synoptical table of consonants, and first of the letter B.*

B.

There is little difficulty respecting the pronunciation and use of this letter, the English and most other Nations giving it the proper sound. In the Spanish, indeed, it is frequently used instead of V, to which the Royal Academy of Madrid gives

* Mr. Sheridan, after having enumerated, in a long list, the great irregularities of the vowels, observes that, "we shall not find the state of our consonants much better."

"B is often mute, as in—*debt, tomb*. C has three sounds, as *k, s, sh*, in *care, cease, social*. F has its sound marked by two different combinations of letters, *ph* in *Philip*, *gh* in *laugh*. G has two sounds, as *gold, gentle*. J has the same sound as that of the 2d. G. *joy*. S has four sounds, *s, z, sh, zh*; in *yes, rose, passion, osier*. T has also four sounds, *t, s, sh, ch*, in *tell, satiety, nation, question*. X has three sounds, *gz, ks, =*; in *example, vex, Xerxes*. Th has two sounds, *then, and thin*. Ch has three sounds, *k, sh, ch*; *chorus, chaise, chair*. Gh has two sounds, *g, ghost*; *f, laugh*; and is often mute, as in *daughter*."

gives nearly the same sound, only softer.* In some of our words the sound of the *b* is no longer used, though the letter be written; as in dumb, crumb, and many others:

C.

C—To this one letter two different sounds are given, contrary to all just rule.† And it serves also in the composition of what are erroneously considered as double letters; namely CH, as in *cheer* (from the Italian *cera*)‡ and CH, in *chasm*; where, however, it only obtains the sound of K, as in Italian words, the aspiration being almost wholly laid aside.

That

* Of the letter V they say: “Su pronunciacion es casi como la de la *b*; aunque mas blanda, para distinguirla de ella, y solo tiene uso en aquellas voces que traen su etimología de las palabras latinas, ú otro idioma en que se escriben con *v*, ú otra letra que se convierta en ella, para no desfigurarlas de su origen.”

Mr. Harris, in his “Philological Enquiries,” gives a specimen from the Formularies of the Greek Court drawn up by Constantinus Porphyrogenitus, who reigned in the beginning of the eleventh century, (according to Dionysius Petavius about the beginning of the tenth) wherein the Greeks at that time used, in their Hellenistic Latin, the B for V, as *Κωνστέβετε Δέος ἡμπέριον βέζερεμ*, &c. for *Conseruet Deus Imperium vestrum*, &c.

† See Beza or Mekerchus as last quoted.

‡ This character and sound of CH seems to have been taken from the Spanish, wherein it is exactly the same; as in *mucho*, much. But Sancho we convert into Sangko.

That this letter *c* was of a hard sound in the Latin, appears, from many instances, beyond a doubt. The Roman title, which we, as well as some others, have melted into the soft sound, *CESAR*, as Dr. Johnson would have it spelt, has in the German language preserved the true sounds of the consonants and diphthong, as *Keyser*. It has often been a subject of dispute among the learned, whether the letter *C* should be sounded like *K* or like *S*; to this Mr. Pope alludes in the *Dunciad*:

'T is true on words is still our whole debate,
Dispute of *me* or *te*, of *aut* or *at*;
To sound or sink in *cano* *O* or *A*,
Or give up *Cicero* to *C* or *K*.

' But it is surprizing that there should be two opinions respecting it; for the generally just analogy between nouns and their oblique cases, and between certain tenses of verbs, is proof sufficiently evident, that the usual modern method of founding the *C*, before some vowels, is erroneous. Whenever *C* is used as an *S*, it ought certainly to have such a mark annexed, as might distinguish it from the hard and genuine sound. Thus, if we must write *CÆ-CIAS* and pronounce *SE-SIAS*, there should be a cedilla, or some such mark below the *s*, as in Spanish and French: or, for the soft sound,

found, it might remain as at present;* and, for the hard found, a point might be inserted within the C, as in some Hebrew letters. No difficulty can arise from K and Q, though one of them is a redundant letter; because, when they are sounded, the sound is always uniform. K before N at the beginning of words is not now pronounced. But in such German words the sound of the k still continues; as *das knie*, the knee.

D.

D—This letter is of an uniform sound in the English, but is confounded with the T by the Germans, who say indifferently, either *Deutch* or *Teutch*; hence, from *taube*, comes the word *dove*, and from *thaler*, *dollar*, &c.

F.

F. "Has always its own sound," as Mr. Sheridan observes, "except in the particle *of*, where it has the power of a *v*, and is sounded *ov*, to distinguish

* In the Russian Alphabet, K and C are distinct; the former having the same sound as we give to it, and the latter that of S.

It appears, from Roman names written in Greek letters, that the C, though not so preposterously used, as to stand for S, had however two sounds, but both analogous; that of K, and that of Γ. As Appian, for Caius Cæsar, writes ΓαίϞ Κæσαρ.

“guish it from the word *off* in sound as well as in
 “spelling. Though it is constant to its sound
 “when single, yet it is frequently marked by two
 “*ff*’s, as in *chaff*, *scoff*; sometimes by *ph*, both in
 “the beginning and ending of words, as in *philoso-*
 “*phy*, *epitaph*; and sometimes by *gh*, as in
 “*laugh*, *cough*.”

G.

G, Like its neighbour and frequent associate, H, is a letter of apparently great business in the English alphabet; but often in fact, is now only a kind of sinecure retainer, superannuated, as it were, and suspended, by modern custom, from much of its ancient usage in the language.

It has its genuine, hard sound in *garland*; it is converted into the English J, as in *gaol*, *gem*, &c.; in *gnat*, *gnaw*, *oglio*, &c. it is silent: before H it becomes hard (like the Italian) as *ghastly*, *gherkin*, *ghes*. The same conjunction, *gh*, at the end of words, is frequently sounded like F, as *tough*. It is silent in *dough*, except in some northern pronunciation.

The SAME GH, in one or two instances, *still* retains its GENUINE, ANCIENT SOUND, which, being uncompounded, I have added to the number of simple sounds in our language; marking it, as some of the other aspirates also, with the Greek χ . Such is its sound in the word LEIGH, the name of a neighbouring town in this County, and
 also

in KEIGHLEY, a town in Yorkshire.* And this pronunciation is nearly if not exactly that of the Hebrew כ or the Greek, Russian, or Spanish X. The latter language has also two other characters of nearly the same kind; as G before an E or I, and J before any of the vowels. The G in the German language has also a similar, if not congenial sound, though with greater latitude; not always depending upon two particular vowels; as *gegen*, *genug*. CH in this language is also of a sound equivalent to the *gh* in Leigh; as *licht*, *recht*, *wicht*, &c. from the same roots from which we derive the words light, right, wight, &c.†

A a

In

* “The word *Lough*, for a lake,” Mr. Sheridan notices, “has a peculiar guttural sound in the Irish pronunciation not suited to English organs, by whom it is generally pronounced *loh*.”

† The English also, as noticed above, can with great facility pronounce the same sound, when, perhaps, so little conscious of doing it, that they would find a difficulty in forming the like termination to other words, beside those they have been accustomed to write and pronounce in that manner: thus few English could aspirate CH according to the Greek and German mode; but to *gh* they readily give that sound. To most words derived from the Greek, and beginning with *ch*, we give the sound of K. but the initials in the word *charity*, which we derive through a medium of pronunciation very different from the Greek, have a sound still more remote from the origin than the sound of the letter

K.

In such words as *song*, *throng*; and the terminations of participles in *ing*; the *ng*, as before noticed, has a half suppressed or nasal sound; as in the words *angering*, *angling*; wherein the sound of the first and second syllables are sensibly different.*

H.

H Is another hackney (of our Alphabet especially) being applied, like the G, to many jarring offices: But in no one instance is any of the four following geminations of letters necessary, though constantly used in a multitude of words. All the sounds which are characterized by *ch*; *th*, as in *than*; *gh*; *sh*; and *th*, as in *thane*,† being really five simply and individually; as every one may easily be convinced of, by slowly founding each; when the same position of the organs of language will be sensible, both at the beginning

K. The French sound of CH is also retained in several words; as *chagrin*, *champignon*, &c. Dr. Johnson says, "It is not to be doubted, but that in the original pronunciation *gh* had the force of a consonant, deeply guttural, which is still continued in some parts of Scotland."

* The ending of some German syllables is precisely the same; as in these words: *jüngling*, *hoffnung*, &c. It is plain, therefore, that Mr. Sheridan did not advert to this circumstance, when he was induced to say: that "per-
"haps this sound is peculiar to the English language.

† Whatever Φ was formerly, *Ph* only retains, at this time, the mere sound of F. and no ambiguity attends the present use of it.

ning and completion of the sound. Moreover, each of these sounds might be continued during the longest interval of respiration, and being then instantly joined with any usually succeeding letter, the latter part of any of those sounds would be as rationally consistent with such succeeding letter, as would any of the parts which preceded; thus, for example, the word *shine*, the continuous sound of *sh* being represented by a continuous line :

sh

Sh—————sh-ine.

Now these positions would not be true, if those double characters consisted of double sounds; a single letter is, therefore, amply sufficient for a single sound. And it is well known, that the Italians do not require a double letter to represent the sound of the Spanish and English CH; for after the powers of their letter C, in its different states, have been once known, there are no further exceptions and irregularities, serving to embarrass a learner. And hence, one individual sound is sufficiently defined by the simple C; as in the first syllable of *cervello*, and the second of *uccello*; which last, as the term for *bird*, is highly expressive of the chirp of one. And, indeed, man seems, by that superior, imitative power, wherewith the Divine Being has qualified him, to have added greatly to his primitive stock of language; as well as to many of the arts, whose

A a 2

growth

growth has more than half concealed their humble, intermediate origins.* The solitary web, spread from leaf to leaf, might first have furnished hints for the ingenious and useful arts of clothing mankind; the Bee and the Beaver may have afforded instructions for forming our habitations; and navigation may have gained its early improvements from that observation of the feathered tribe, to which superstition incited many of the ancient inhabitants of the world.

The ALMIGHTY has, indeed, only endowed with a certain, limited knowledge those creatures, which he has subjected to man; but on man himself HE has bountifully bestowed an innate curiosity and progressive capacity, for inquiry and science. This curiosity and this capacity need, however, the guidance of Reason, lest short lived man should find himself too long bewildered in the labyrinths of illusory and fruitless objects of pursuit.

But to pass on to the subject. We not only find that the above five simple sounds are characterized by double letters, but, also, that CH is sometimes used
for

* Erasmus in his Dialogue, upon the pronunciation of Greek and Latin, has humourously made a Bear and a Lion the speakers; and the lion gives a pretty long enumeration of sounds, imitated by the human voice. See Erasmi Op. vol. i. page 915. le Clerc's Edit. Hippocrates says, that a rational life is a life of imitation. διαίτην ἀνθρωπίνην μιμνέται.

for the English SH.* which, in some Alphabets, is marked by one independent character; as ש, in the Hebrew, and in the Russian, by Ш, a letter something consimilar.† Thus, in like manner, every

* See the note upon the latter G.

† Beza says “ that X altogether answers to the ש “ with a dexter point, and the French CH (or English SH) to that with a sinister point ש, and it is his opinion “ that the former was improperly called *shin*, and that the “ latter is falsely confounded with D. For to the Ephraimites, he observes, (as related in the twelfth chapter “ of the book of Judges) it happened, unfortunately, “ that they knew neither of the sounds of *chin* (i. e. as he “ thinks, X) but, to a man, pronounced it as D.” Whereas, by a true pronunciation, they might have passed unsuspected of being enemies.

Now by the way, the passage, to which he alludes, is not altogether so clearly expressed in the Septuagint translation, as it admits of being. For the very word should be inserted, (with an explanation ^a) which was proposed to the Ephrathites, as a test, whereby they might be distinguished from the Gileadites, but, as they are not so inserted, it is a proof, among many others, that the Greeks had no letter of the sound of ש, and were, therefore, obliged to leave the sense a little obscured. The words are briefly compared as follows: *And the Gileadites took the passages of Jordan before the Ephrathites: and it was so, that when the Ephrathites which were escaped, said, each,*

וַיֹּאמְרוּ לוֹ אֲנֹשִׁי-גִלְעָד הָאֶבְרָתִי אָתָּה
וַיֹּאמֶר לֹא : וַיֹּאמְרוּ לוֹ אֶמְרָנָא שְׁבִלָת וַיֹּאמֶר סְבִלָת
וְלֹא יָכִין לְדַבֵּר כֵּן

The

^a. As in Matt. chap. i. 23. and elsewhere.

every simple sound should have its own inalienable note of distinction. The softer *th* Mr. Sheridan has marked by a line across the *h*; as *th̄* which in the Castillian has the single character *z*. but, if *th* must remain, would it not be better to conjoin them so as to appear as they ought, one type, with one properly expressive name as *the* or *eth*; and so likewise *eg* or *ge*; *esh* or *she*, each with some small mark for distinguishing the anomalies: thus, not to render books unintelligible to posterity by expunging any thing, all the old constructions of the alphabet might be reverently preserved both by pen and press.

Now in regard to the sound of *ch*; as in *chill*, it does not appear to me that any one has noticed that we have a simple alphabetical character expressive of this

The words in the Greek, which ought, at least, to be parallel to the above original, are: καὶ ἔειπαν αὐτοῖς ἄνδρες Γαλαὰδ, Μὴ Ἐφραθίτης εἶ; καὶ ἔειπεν οὐ. Καὶ ἔειπαν αὐτοῖς, ἔπον δὲ ΣΤΑΧΥΣ. καὶ οὐ κατεύθυνε τῷ λαλήσαι ὁτως.

This is the same as if it were translated:—And 'the men of Gilead said to them (*individually*) art thou an Ephraimite? And he said, No: And they said to him pronounce then EAR OF CORN: and he could not contrive to pronounce so.—Now, would not our English translation also be better thus: and the men of Gilead said unto *each* art thou an Ephraimite? If he said, nay: Then said they unto him, say now shibboleth (*which signifieth an ear of corn*) and he said shibboleth: for he could not frame to pronounce it *exactly* (*b*) right.

b. Exactly, or some such adverb, the verb being in *pihel*.

this found: yet true it is that such letter is H, whereto we give the name of *aitch*,* and this really comprehending the found which is continually preceded by an uselefs associate. This simple character is called *etch* in the Synopsis.

But to consider H in its usually simple, unconnected form, as to other consonants, we are taught that it was originally used as a mark of aspiration by the Greeks,† and continued as such with the Romans as long as their language.

In

* In the Russian language this found is judiciously marked by *one letter*, and that exactly like our small h inverted thus *и*.

† For *ἐναλον*, they wrote *Ηεναλον*; &c. but afterwards dividing the letter, thus, *Η*, the first moiety was used for the aspirate; and the latter was unnecessarily placed to shew that the vowel was not aspirated.

It seems fashionable, in much modern printing, to lay aside both these marks, as well as the accents, altogether: whereas one of them and the accents are frequently of great use, in discerning words of similar letters, but different meaning: although it appears true, as many have asserted, that there is no analogy between the present and the ancient rules of accent, which last never offended against the rules of quantity. Concerning accents, Aristotle says: *περὶ ὧν καὶ ἕνασον ἐν τοῖς μετρικοῖς προσήκει θεωρεῖν*.* From the present use of the accents, however, the ear will derive but small assistance or satisfaction: it is the eye which must make the distinction between words,

* See Winstanley's Edition of Aristotle's Poetics, page 64.

In the English, too, it generally serves as a weak aspirate at the beginning of words, but even in this case, the article *an* is almost as often prefixed as if the *h* were silent; which destroys in a great measure the force of the aspirate, and sometimes to a hearer gives consequently an equivocal sound.* This often occurs, not only in the hurry of conversation, but also in the more deliberate acts of writing and printing.

An owl, and an ox, are not oftener written and printed perhaps of late, than *an house*, *an horse*, *an history*, and such like words. But this use of the article is very unlike its application in the words which the poet gives to King Richard, as noticed by Dr. Johnson:

A horse! a horse! my kingdom for a horse!

Where

words, whose form and quantity are the same; and without the accents, or some substitutes for them, what difference is there between such words as *αγγῆς*, *albus*, and *ἄργης*, *serpens*; *ἄρκος*, *ursus*, and *ἀρκὸς*, *auxilium*; *εἶος*, *vita*, and *εἰὸς*, *arcus*; *θεὰ*, *dea*, and *θέα*, *spectaculum*; *ψύχη*, *papilio*, and *ψυχὴ*, *anima*; and a great number beside? The context, it is true, might often lead to the sense, and might as often leave it involved in ambiguity: *ἔτοι ζῶσι* signifies, *these men live*; *ἐτοι ζῶσι* means quite the reverse.

* Before words, wherein custom has only retained *h* for appearance of etymology, without giving it any sound, the case is very different; as, *an honourable house*, &c.

Where the very hiatus, which ought to be made in pronouncing this line, speaks the strong emotion of a person, half breathless, through despair and fatigue, and yet still anxious to win the glory of a momentous day.

Some modern caprice would perhaps write,

An horse! an horse! my kingdom for an horse!*

In which case it would be no unpardonable mistake, should some part of an audience imagine, that the poor gentleman was calling out for —

A nurse! A nurse!

H is used also after R in some words from the Greek; as *Rhetorick*, *Rhythm*, &c. but without any found. And after the vowel W in English words it is very common; and is in such case frequently founded: moreover it is observable, as Dr. Johnson remarks, that though the aspirate follows the w in appearance, yet in pronunciation it has precedence, and ought, therefore, to be so written.† For

B b, fuch

* Such article may and ought to be prefixed, instead of *a*, to all words beginning with the silent *h*; as *an herbal*; &c.

† And it would be equally intelligible, with a better analogy, as:

" *Hwo* finds not Providence all good and wise,

"Alike in *hwat* it gives and *hwat* denies?"

This, at first sight, appears uncouth; and the eye must continue to be gratified at the expense of propriety.

such aspirate, the semicircular Greek note would be as convenient as the H. * Such novelties, however, notwithstanding they might help to rectify some words, and to obviate the necessity of retaining their useless incumbrances, would, perhaps, gain few advocates among the number of such opinionists as fancy, because they will not examine, that the common exuberances, or rather the intrusion of some letters, and the improper commutation of others, are no blemishes: though truly, as in cases before alluded to, they impede pronunciation, and might sometimes throw a shade upon the sense.

J.

J is a character which in English is always uniformly the same, whatever vowel it precedes; its sound is distinct, and formed independently of other simple sounds; as is also the *soft* G, which ought, reasonably, to have some minute symbol of distinction; a score of which might be described, any one whereof might serve to note the variation of sound, without incumbering the letter, or misleading those already acquainted with its various applications.

* The words $\bar{\upsilon}\omega$, $\bar{\upsilon}\epsilon\nu$, $\bar{\upsilon}\nu\phi$, are equivalent to *who*, *when*, and *where*. The *whistling wind* and "*whirring pheasant*" may be well written (for example) $\theta\epsilon \bar{\upsilon}\iota\sigma\lambda\iota\nu\gamma \mu\iota\nu\delta$; $\bar{\upsilon}\iota\phi\phi\iota\nu\gamma$ pheasant. Then why not have used our own letters in a manner as little complex?

applications. Both G and J might be called *ge* or *ja*; for the soft sound: and, for the hard sound, G might be called *eg* or *ghe*. A point, within, might distinguish G as it does C.

The sound of the French J is exactly that of Z-ya, quickly pronounced as one short syllable: and this compound sound is audible in many English words, where Z precedes a diphthong, of which the first vowel is I (or Y) as in *azure*, equivalent to *aziwre*, for the *u* in this word is a diphthong, and might be conveniently characterized by a point over the *u* in this manner *ü*. *Leisure* upon the same principle, by the different pronunciation of the S, comprizes also the same sound, *leiz-your*.

On the contrary, there is no sound of Z in the formation of the soft English G or J, which are pronounced like G in the Italian adverb, *Già*. They are indeed mere unisons, as is each of the following sounds, *eth*, *esh*, *gh*, *sh*, and *eh*, or *etch*, which is collaterally relative to G; and though the letter *d* may be supposed nearly related to J and G, as forming a part of the sound, because we write, *edge*, *judge*, *wedge*, &c. yet the reverse is most probable; for it may be observed that the *d* in those words cannot be completely sounded without dividing the word into two syllables, *jud-ge*, making a great hiatus in the pronunciation; which would not be the case if it were congenial with any part of the sound of G. It follows, therefore, that no true assimila-

tion takes place, between the *d* and *g*, in pronouncing the word *judge*. And, indeed, if the *d* were omitted, it would in no degree, affect the sound of the *g*: it would be the preceding vowel, *u*, which would be altered—from its short, close sound, to that of the longer *u*, as in *ruby*.

K.

K may here be passed over; as it was noticed under the letter C, which is its frequent substitute, and, when so, ought like other ambiguous letters to have a mark of distinction. See page 183.

L.

“ L has always one uniform sound, and is never silent but when followed by an *m* in the same syllable, as *balm*, *psalm*. In one word only it is founded as *r*, colonel—pronounced *curnel*.”

By retaining the *l* in such words as *balm*, &c. it seems in part that we have followed the original, in the spelling, and the French analogy in the pronunciation. Indeed the French formerly wrote *baulme*, *pseaulme*, &c. with *l*. But in reference to the word *colonel*, the sound of *r* is in no respect heard, unless in conformity to an etymology differing from the French, from which we have taken the word:
on

on the contrary, it is, as Dr. Johnson observes, “generally sounded *col'n:l*” by the mere elision of an *o*. And, without the elision, the *l* has its proper sound in the following lines, by Dean Swift :*

No subject fit to try your wit
When you went *colonelling*.

Butler also, in the first Canto of his Hudibras, says,

Then did Sir Knight abandon dwelling,
And out he rode a *colonelling*.

Where, the metre requiring the pronunciation of all the syllables, the latter word of each couplet cannot be *curnelling*. It is true that in *Spanish* this office is written, and therefore properly pronounced *Coronel*; but who will say that this argues a single point in proof that *L* ought to be pronounced as an *R*?

L unites into an agreeable, liquid sound before the conjoined diphthongs *IE*, *EU* and *U*, when this is equivalent to *IU*, as it is in a multitude of syllables; and also before *ew*, which has the same sound; as, likewise, *ieu* in the English pronunciation of *lieu*. Such liquid sound is in the
words,

* In his answer to Ballyspellin, written by Dr. Sheridan.

words, *lute*, *lubricity*, *alien*; *modillon*,† *pavilion*, *quintillion*, and many other. But in words beginning with *lio*; as *lion* and its derivatives, the first letter after the *L* is the diphthong *ai*, or *oi*, wherewith the *L* does not blend into the above liquid sounds, because the simple *i* or *y* is intercepted by a vowel of greater density; a *diæresis*, therefore, though not expressed, is to be understood (as in many

† The *LL* of Spanish words (which seems to be converted sometimes from the *Cl*, and, at other times, from the *Pl* of their Latin roots) is applied to exactly the same sound as that of our most liquid *L*, but with a greater latitude; for it precedes all the vowels, except *i* and *y*. And the reason why it glides into the liquid sound before *a*, *o*, and *u*, is, because the pronunciation *ll* is every where followed by the audible, although invisible power of an *i* or (which is of the same sound) *y* rapidly absorbed, as it were, by its consecutive vowel. Such is the nature of *llamar*, *lleno*, *llaver*, and *lluvia*. And just the same is the Italian *gli*, as in *foglio*, *figlia*, *oglio*, whereof the endings are like those of *folio*, *battalia*, *olio*. Mr. Baretti mistakes, therefore, when he supposes that we have neither this sound nor that of *gn*, in *bagnare*, *mignon*; for, as well as the liquid *l* already exemplified, instances shall be adduced, under the letter *N*, to shew that we also have this liquid sound, ascribed to *n*, which depends entirely upon a state of the vowels, correspondent to those which give the liquid sound to *l*. And this soft union of the vowels is similar to the *synæresis* used in Greek poetry, where in the Ionic dialect the *ε* is rapidly blended with the following vowel, so as to form only one syllable, as,

Μῆνιν ἄειδε, θεὰ Πηληϊάδεω Ἀχιλῆος.

many similar cases) as belonging to the *o* in those words, as *lion*, making two syllables of *i-o*: but for the liquid sound the *i* and *o* blend into one syllable *yo*. All simple vowels follow their general analogy and irregularity, without influencing the *L* which they happen to succeed; as *linen*, *lot*, *lote*, *lustre*, *lynx*. It is an error, therefore, to think that *L*, or *LL*, has any independent, liquid sound more than that in *lute*: for the common appearance of words proves nothing; it is the ear which must analyse sounds, whilst the eye should direct the best means of preserving their distinctions.

M.

M is always an unison, and not different from the same named letter of other languages; except that in French words it is sometimes turned into a sound nearly like our *ng*; as, *temps*.

N.

N has very few exceptions to its regularity. The chief is its being in some instances silent after *m*.

It is often associated with the before mentioned diphthongs, *ie*, *io*, &c. and forms the soft sound, which, in Italian, is characterised by *gn*, and in Spanish by *ñ*, which is an abbreviation of uniform sound;

found;* such as *aña*, *cañero*, and many others. These sounds we have; as *champignon*, *dominion*, *onion*, *poniard*, *pinion*, *spaniel*, *trunnion*, and others.

P.

P is as regular and constant to its sound as the foregoing consonant. In Dr. Johnson's words, "it has always the same sound, which the Welsh and Germans confound with B. It is sometimes mute as in *psalm*, and between *m* and *t*, as *exempt*. PH is used for *f* (at this time) in words derived from the Greek, as *Philosopher*, *Philanthropy*, *Philip*."

Q.

Q has been noticed before, under C. Its sound is almost every where uniform in English words: but in a few, derived from the French, the vowel *u* is not pronounced;† as in *casque*, *masquerade*, and several other words.

R

* Ñ is a character which, before *a*, *o*, and *u*, has the power of *ni* or *ny*; for the word *aña* is resolvable into *an-ya*. The GN (in *bagnare*) may also be readily expressed, in English letters, thus, *ban-ya-re*.

† The letter U, when pronounced, after Q, always retains its genuine vowel sound: thus we do not say *eloqew-ent*, but *eloquent*; not *eqew-ator*, but *equator*, which is the same as *equator*. On the contrary, the word

mute

R.

R is in the English always nearly the same; and but seldom so strongly vibrated as in some French words, such as *Roi*.

S.

S is both in sound and form a serpentine letter, for it “has a hissing sound, in *sibilation*, *sister*. S “single, at the end of words, has a grosser sound, “like that of z, as *trees*, *eyes*, except *this*, *thus*, *us*, “*rebus*, *surplus*,” and some others.

“It sounds like z before *ion*, if a vowel goes “before, as *intrusion*; and like s, if it follows a “consonant, as *conversion*.

“It sounds like z before *e* mute, as *refuse*, and “before *y* final, as *rosy*,”* and several others which may be seen by referring to the Grammars of Dr. Johnson and Mr. Sheridan.

As to the character *zh*, which this Gentleman applies to denote the sound of the *s* in *oxier*, and words of similar ending; it seems, indeed, analogous to the character *sh*; but as this double letter, as before observed, is, through want of a simple character, used as the symbol of an independent sound, though it is demonstrable, by analysis, to be no further expressive of such sound than as far as necessity and custom have united incongruities; so must

C c

the

the character *zh* be equally inapplicable to the sound of the French *j*.

The mistake seems to have arisen from having given powers to the consonant which really depend upon the vowels which immediately succeed it: and a simple vowel, as already noticed, has no influence; it must be a diphthong, of which the first part is one of the very slender vowels, *i* or *y*; (sounding as *ee* in *tree*) thus in the words, *azure*, *osier*, a diphthong follows both the *s* and the *z*; and let the sound of *z* be given as usual to the *s* in *osier*, and the analysis will be thus: *oz-yer*. *Y* is used here, rather than *i*, because the slender sound is oftener given to it than to the latter, and it therefore better answers the purpose of explanation. *Azure* admits of a similar analysis; the diphthong *u*, founded *you*, follows the *z* — it might therefore be expressed thus: *az-your*.

Perhaps also the sound of —*sion*, at the end of words, depends rather upon a like analogy of the diphthong, *io** or *yo*, than upon the full sound of *sh*; as the word *fusion* may be thus described: *fuze-yon* or *fewz-yon*.

The termination, —*tion* may be tried by the same rule: thus, if the *t* be perverted to the sound of *s*, it might be nearly expressed as follows; *acs-yon*, from *action*.

So

* See page 171, where this character is united, and has the sound of *you* or *yo*.

So likewise *martial*, *partial*; *conscience*, *patience*; and words of such termination, might be resolved into *mars-yal*, *pars-yal*; *cons-yence*, *pace-yence*; in all which examples the rapid concurrence of the two last syllables, *i-al* and *i-ence*, is indispensibly necessary for giving the required found.

The word *question*, without perverting the *t*, may be analyzed *quest-yon*.

From this examination it appears, that the full found of *sh* is not congenial, nor indeed used in the above words; but is rather to be considered as one of the depravities of pronunciation, which time or caprice may now and then have insinuated into the language.

T.

T has always its genuine found; as in *tablet*, except in the above and similar terminations, and in the word *satiety*, pronounced *safee-ye-ty*.

V.

V is every where in the English of one equal found, " of near affinity with *f*. From *f* in the " Islandick alphabet, *v* is only distinguished by a " diacritical point."* Indeed such points would give every requisite precision to an alphabet, and correct the incoherent assemblage of characters.

C c 2

X is

* Dr. Johnson's Grammar.

X.

X is an unnecessary symbol of two pair of consonants, *ks* and *gz*. Few mistakes, however, arise from the use of it.

Z.

Z, though noticed before, under the letter S, requires thus much further to be said concerning it, that, if it precede a single vowel or any diphthong, beginning with *i*; as *ia*, *ie*, *io*, *u*, it always preserves its soft sound; and it is some such diphthong (*but in no respect a consonant*) which unites therewith to form the sound of the French J, which is merely a convenient and unperverted abbreviation in that language for the letters *z-ya*,* as it is called in repeating the alphabet; as *jardin* is resolvable into *z-yar,din*; *joindre*, into *z-ywain,dre*; *justice*, into *z-yous,teece*; making only two syllables of each word, as divided by the comma. Whereas the letters *zh* cannot be resolved in any such sounds; for *h* can only stand for the aspirate, *ha*, or, if it will be allowed, for the sound of *etch*. Hence, if *z* should be combined with one of these sounds, what other sound would be the result than *z-ha* or *z-tch*? *Tch* being here sounded as at the end of the word *thatch*, which might be explained also by similar sounds,

though

* In reality it is only *z-y*, which, according to the vowel which may happen to follow, is one or other of the following sounds: *z-ya*, *z-ye*, *z-yee*, *z-yo*, *z-you*.

though differently written, in other languages. For indeed no one language can sufficiently explain its own sounds unless *vivâ voce*; therefore, in order to give any explanation upon paper, continual reference must be had to analogous sounds in some other language; for as the adamant must be applied to illustrate every gem of the same kind, so, to explain one language, assistance is to be sought for in others, as has been done in the course of this Paper: and if the arrangement of the Alphabets (*opposite page 177**) be correct, or *nearly so*, then may the English be allowed to possess, in that table, the greatest number of

* Having frequently thought, that machinery might be constructed, by an ingenious artist, for imitating the sounds of the human voice, as well as organs have been formed for the imitation of the tone and powers of various musical instruments, I was not greatly surprized at finding, by a paragraph in the General Evening Post of May 31, and by an account in the Analytical Review for the last month (June) that a M. Von Kempelen, of Vienna, has lately invented such a machine, and published a description of it, with plates. Experiments therewith would incontrovertibly decide upon the nature and comparative powers of each language it may be brought to imitate. At present
 “ it is said to give correctly the sound of all the vowels
 “ and all the consonants; but the latter are combined
 “ and expressed with some difficulty. Of consequence
 “ the ingenious inventor has found it better suited to
 “ *Italian, French, and Latin*, than to his native language.
 “ But he has hopes of introducing considerable improve-
 “ ments, and arranging it in such a manner, that it may
 “ be played upon with keys, in the manner of an Organ,
 “ and with equal facility.”

of elemental sounds. But sounds alone, without a skilful mixture, and apt disposal into words, are not enough to give superiority to a language in any greater degree than merely as a greater variety of colours would excel a judicious design in *chiar-oscuro*,* or as the wild concurrence of many musical tones would surpass the scientific touches of a few well tuned notes. The harmony of colouring is perhaps a thing not yet completely understood: painting by the eye alone, may be like playing upon an instrument only by the ear; when neither all eyes nor all ears can be equally correct.†

If such things be so difficult, how much more so must be a knowledge of the complete harmony of the far more numerous elements of language, taking consonants and vowels together. Such a knowledge may, possibly, be reserved for man, as one part of his expectations in the spheres of future happiness.

As the fallen leaves and scions of the forest are, at one time scattered abroad, and again driven together

* This is only to be understood as far as it relates to the ear; for it is sufficiently evident, that ideas may be conveyed to the mind by the most unpolished languages; nevertheless it is always most agreeable when sounds seem to harmonize with ideas. Mild and gentle thoughts should not be uttered with tones of asperity; nor should soft words be used for expressing the boisterous passions.

† See the relative harmony of musical notes, colours, and vowels, page 172.

gether by alternate gusts of wind, so have emigrations and shipwrecks, and the storms of invasions and conquests, scattered over the globe an astonishing multitude of the half mutilated germs of language; which, taking new root, have continually favoured the fortuitous change and assemblage of words, thereby defying all conjecture, as to what the precise form of language was, before the confusion at *Babel*: nothing occurs, however, to prohibit the admission of an hypothesis, that it was, at first, as **He** who gave it is, **PERFECT**.

And, indeed, the Holy Scripture so far informs us, that, previous to the change at *Babel*, "*the whole earth was of one language and of one speech.*"* How, then, is to be reconciled with this account, some passages of the preceding chapter? As at verse 31st. † "*These are the sons of Shem, after their families, after their tongues, in their lands, after their nations.*" Why after their *tongues*, when it is related, that there was at that time (and the whole succeeding context supports this passage) only one language over all the earth? Novice as I am in the original language of the Sacred Writings, I scarcely dare to hazard any opinion upon these seemingly contrary readings, without very great diffidence. I appeal, however, to the learned in the language, whether transcribers might not have mistaken, even the three times, one of the following

* Gen. xi. v. 1. † And also at v. 5. and v. 20.

lowing words for the other: that is to say לְשׁוֹנָתָם for שְׁמֵתָם the former word signifying, according to their *tongues*; but the latter word, according to their *NAMES*.*

It may be opposed to this, however, in order not to admit rashly any ill founded or premature opinion, that the passage, as it is, notwithstanding its apparent priority, through so many ages and translations, ought, perhaps, to be received rather as an anticipated register of persons and events immediately succeeding the general confusion of speech, than as relating to time antecedent.

So

* I cannot help expressing, in this place, an earnest wish, that it may become as fashionable, with all professors of the benign principles of Christianity, to read the ancient volume of Sacred History in the original words, as it is to read, in their respective languages, the genealogies of *Hesiod*, or the philosophy of *Lucretius*. And it would certainly be much less difficult to do so.

Numerous are the guides thereto, printed in Latin. And, with the laudable view of more generally promoting such knowledge, a few learned men have at different times deserved the thanks of their country, for publishing also easy directions for the attainment of the Hebrew, without any previous knowledge of the Greek or Latin. See ample and convincing reasons for giving a small portion of time to such study, in the prefaces to Robertson's "Gate, or Door to the Holy Tongue," first printed 1653; and Dr. Bayley's "Entrance to the Sacred Language," printed 1782.

So far upon the subject of the comparative varieties and abuses of our Alphabetic Characters; but, so far, within a much more contracted compass than the extent and importance of inquiry still allows: yet as an attention to this Society urged the contribution of some paper to the common stock, so now several considerations exact the conclusion of this Fragment.

On the ACTION of METALLIC OXYDES and EARTHS upon OILS, in low Degrees of Heat. By MR. PETER HENRY. Communicated by MR. THOMAS HENRY, F. R. S. &c.

[READ NOV. 16, 1792.]

THE high degree of colour, possessed by many of the expressed and fatty Oils, rendering them unfit for several uses in the Arts; it appeared to be a desirable object to discover a mode of depriving them of their colouring particles.

For this purpose the following Experiments were instituted.

1. Two ounces of Sperma Ceti Oil were digested, with one drachm of white arsenic, in a heat of 180° of Farenheit, during six hours; and left to stand till morning. The oil was then perfectly clear, and colourless, and much heavier than it was previously to the experiment. A great part of the arsenic, however, remained undissolved, at the bottom of the digesting vessel.

2. Two ounces of Linseed Oil were digested with one drachm of white arsenic, under the same circumstances with the former. In the morning very little alteration being perceived in the mixture, it was exposed to a somewhat greater heat. In two hours the oil appeared brighter, and clearer, much of the arsenic being dissolved; but it yet retained a great part of its original colour. There was a considerable deposition of mucilage; the arsenic, which remained undissolved, being tinged of a light yellow colour.

3. Green olive oil was treated in a similar manner with the Sperma Ceti oil, and attended with the same result.

4. Thick train oil was digested with a drachm and half of white arsenic. No great alteration was observed in the colour of the oil, though it was evidently rendered clearer and more limpid.

When the oils were at the greatest heat, a brisk effervescence took place in all of them, upon shaking up the bottles, but immediately discontinued on the arsenic being suffered to subside. When poured

on

on the hands, they instantly shrivelled the skin, and were either absorbed, or soon dried up. Two phials of Nos. 1 and 2 being left exposed to the action of air and light, for some months, were not in the least changed.

As it was evident, that a considerable portion of arsenic was dissolved in all the foregoing experiments, I wished to see, if it could be precipitated; and at the same time the oils be left pure, and deprived of colour; though with no great hopes of success, from the known property of the mineral acids to render oils thick and discoloured.

5. Part of No. 1 being poured into a phial, three or four drops of strong vitriolic acid were added. The arsenic immediately precipitated, leaving the oil as pure and colourless as before.

6. The same quantity of vitriolic acid being added to Nos. 2, 3, and 4, the arsenic was in like manner precipitated. No. 2 seemed even clearer than before the addition of acid.

7. Nitrous acid being added, in the same proportion with the vitriolic, the colour of all the oils was instantly changed to a dark brown, except the *Sperma Ceti* oil, which was not much affected; the train and lin-seed oils suffering the greatest change. In all of them a slight effervescence took place.

8. Marine acid occasioned a precipitation, which soon redissolved, in all of them.

9. Both the fixed alkalies immediately coagulated the oils, the water, in which the solution of alkali

was made, subsiding to the bottom of the vessel, along with the arsenic.

10. Three ounces of Sperma Ceti oil were digested with one drachm of litharge, during six hours, in about 200° of Farenheit. The oil became much clearer than before the experiment, but not near so colourless, as when treated with arsenic. The litharge was changed to a white colour. Part of the oil being poured off, and the heat afterwards increased, it soon became thick and high coloured.

11. Lin-feed oil exposed to the same degrees of heat, under similar circumstances, underwent the same changes.

12. Train oil was little affected in low degrees of heat, but in higher degrees, became discoloured.

13. A few drops of vitriolic acid being added to a portion of No. 10, before the heat had been increased, the litharge was precipitated, and the oil left pure and clear, though not quite colourless.

14. Vitriolic acid being added to the lin-feed and train oils, No. 11, and 12, a very small precipitation of the litharge took place, probably owing to the heat not having been sufficiently great to dissolve it in large quantities, which had been found to be the case with the same oils, when digested with arsenic.

15. Nitrous acid, when added, instantly changed the colour of all three to a dark brown; the oils No. 11 and 12 became thick and glutinous.

16. Marine

16. Marine acid precipitated the litharge. Upon being left to stand, the lin-feed and train oils assumed a much darker hue, than they had previous to the addition of the acid.

17. Alcalies coagulated the oils, as in the former experiments with them.

18. Two ounces of Sperma Ceti oil and half a drachm of red lead were digested during eight hours. The oil seemed not in the least changed; but a small quantity of the lead remained suspended, and gave it a slight pink cast. The heat, the next day, was gradually increased with as little success, till the oil being brought to nearly a boiling heat, it became dark and discoloured.

19. Lin-feed oil was tried in the same proportions, with the like result.

20. Train oil was treated, in the same mode as the others, with one drachm of red lead. On increasing the heat, it formed a very thick, dark coloured mass.

21. White lead, and the oxyde of copper, which is formed upon the distillation of acetated copper, had the same effect with the red lead. But less of the oxyde of copper appeared to be dissolved, than of those of lead.

Not meeting with the success, from the digestion of the oils with the metallic oxydes, which I was at first led to expect, I submitted them to the action of different pure aerated earths under the same degrees of heat.

22. Two

22. Two ounces of Sperma Ceti oil, and one drachm of the earth of Alum, precipitated from a solution of Alum, by the vegetable fixed alkali, were placed in a sand heat from 180° to 190° of Farenheit, and suffered to remain there during three hours. The oil became clear and colourless, the gluten having precipitated with the earth to the bottom of the vessel.

23. Two ounces of linseed oil and one drachm and a half of pure clay were subjected to the same degree of heat as the Sperma Ceti oil. This oil likewise, became very clear, and much less coloured. A considerable deposition of mucilage was observed upon the surface of the clay. The combination of the mucilage with the linseed oil appeared to be much stronger, than that of the Sperma Ceti oil with its gluten.

24. Train oil was likewise rendered much purer by digestion with the same earth, but was in no degree equal either to the Sperma Ceti, or linseed oils.

25. Both aerated and pure Magnesia precipitated the mucilage, whilst the oils continued warm; but as they cooled, the mucilage and magnesia rose and mixed again with the oils.

26. Ten grains of pure calcareous earth being added to one ounce of each of the oils, in the cold, turned them thick, and dark coloured.

27. Aerated calcareous earth had little effect upon the oils, either heated or cold.

In

In all these experiments with the earths, not the smallest particle seemed dissolved, as on the addition of any of the acids, they instantly changed to a very dark colour. Those oils to which the nitrous acid was added, became much darker than those in which the metallic oxydes had been digested, and to which the same addition had been made.

It is well known, that oils obtain the property of drying more quickly by being boiled, either alone or in conjunction with metallic oxydes, and argillaceous earths. Oil, according to M. Lavoisier, consists of Hydrogene, or the basis of Inflammable Gas, and Carbone, the basis of Carbonic Acid, or fixed Air. The metallic Calces consist of the Metal united to Oxygene, or the basis of pure air. According to this system of Chemistry, the Metal when boiled in oil gives up Oxygene to it, while the Mucilage of the Oil unites to the Metal. It seems therefore propable, that in high coloured Oils, the Carbone is superabundant, and that by digesting the calces of Metals, in a lower degree of heat, a part of the oxygene of the calx may combine with the superfluous Carbone, and, forming Carbonic Acid, tend to divest the oil of its colour, while the oxyde, attracting the mucilage, may contribute to the same end.

How far this theory may apply to the explanation of the foregoing experiments, I do not pretend to determine. It is remarkable however, that one of the earthy substances, viz. the alumine, which is not known to contain either oxygenous or carbonic
gas,

gas, de-coloured the oils more powerfully than most of the metallic oxydes, and equally with any of them. This earth has a strong attraction for colouring matter, and on this property depends its use in dying.

But on the supposition that the above theory is just, it may be expected not only that the oil may be deprived of colour, but that rancid oils may be restored to sweetness by the metallic oxydes. My Father formerly found,* that rancid oil, exposed to streams of carbonic gas, was sweetened. The same effect may be produced by the same gas formed in the process; and indeed, though I was not particularly attentive to this circumstance, I thought the train oil was diminished in rancidity; and the Sperma Ceti oil, which was kept for several months, after exposure to heat, continued sweet.

Another circumstance, worthy of remark, is, that though concentrated vitriolic acid, on addition to oils, blackens them, and gives out a sulphureous smell; yet when dropped into oils, in which the metallic calces have been digested, it combines with the calces, and precipitates them, without either discolouring the oils, or changing their odour.

* Henry's Experiments and Observations, page 129:

ADDRESSED TO DR. PERCIVAL.

October 30th. 1792.

SIR,

I have transmitted to you the following account of an ancient Mode of Sepulture, that has taken place at one particular period in this country. Your communicating it to the Members of the Literary and Philosophical Society of Manchester, will much oblige,

Sir,

Your most obedient Servant,

ALEX. COPLAND.

*King's Grange, in parish of Urr,
Stewartry of Kircudbright.*

[READ NOV. 30, 1792.]

THE tumuli or heaps of stones thrown promiscuously together, called by the people of this country *Cairns*, being more frequent in this district than in any other part of Great Britain, there have been frequent opportunities of late years to examine their contents, from the Proprietors carrying away the stones, in order to construct dry stone fences,

E e

and

and other buildings necessary for the improvement of their lands. About the middle of the Cairn, and on a level with, or a little elevated above, the earth's surface, there are always several thin flat stones laid horizontally in a circular form, with their edges close applied together, without any cement, upon which are generally found entire bones, their fragments, or reddish coloured earth, like ashes, and sometimes entire urns, pateræ, or clay vessels, slightly burnt, turned with their mouths down, over ashes or fragments of bones, that appear to have been subjected to the action of fire. The heads of spears and arrows, both of brass and iron, with large rings* of these metals, have, at times, been met with. These urns or pateræ are seldom quite entire; they, and the ashes or fragments of bones, are generally surrounded by flat stones, so laid, without any cement, as to form niches about one foot and a half long, by ten or twelve inches broad, and from twelve to fourteen inches deep. But the size of these divisions varies greatly. In some instances, they are more than three feet long by two broad, in which the bones are always found more entire; but in others they are very small, when they are found to contain no fragments of bones, but only a little red coloured earth, like ashes;

* These rings were of a size that would have suited the ends of their spears.

alhes; and, in a few cases, these divisions have been observed to be constructed in a circular form. The number of these niches varies, from two to twenty, or more, under one Cairn. No regularity appears in the laying of the stones, except that the base is always filled up by large, round stones, laid in concentric circles round the above-mentioned pavement of flat stones; all the remainder of the Tumulus being constructed of globular stones thrown together, from the size of (or a little larger than) a man's head to that of his fist, and without any flat stones at top; but the Cairns generally put on the appearance of perfect cones, ending mostly in one large round stone at the apex. In many of them small fragments of bones are found equally dispersed through every part, which, with their frequency in this corner, there being about a hundred of them in the neighbouring parish of Crofmichael, and one or two at least in each farm through the greatest part of this parish of Urr, tends to shew that these Cairns have been the common Cemeteries, or places for depositing the bones of the dead belonging to the whole neighbourhood. They are always situated on ground a little elevated above that which surrounds them. There is reason to conclude, that wherever the remains of any Chief of a District, or Founder of a Clan, came to be deposited, not only the rest of his Family, but also his whole

Dependents or Clan would wish to have their bones deposited in the same spot.

From the people in this country having for a long time very little intercourse with their neighbours, as Galloway continued several hundred years an independent Sovereignty from the rest of Scotland,* being one half surrounded by the Sea, and the remainder by ranges of very high Mountains, it is probable that they continued the practice of burning their dead, longer than in other parts of the Island, and, in all probability, for some time after their conversion to Christianity. From the following description of a Cemetery, that seems to partake of a mixed nature, viz. both of burning and inhuming, and from the instrument of iron being found almost perfect, and very little hurt by rust, which appeared to have been used for consuming the corpse, with a small quantity of fuel, it is probable that the burning of dead bodies has not been in disuse so many hundred years as is generally imagined.

Having occasion to build a dry stone fence on my ground, the workmen, in order to get stones, easily went for that purpose to what had the appearance of an old inclosure. It was situated on a piece of ground

* See a Dissertation on the Kingdom of Galloway in *Archæologia*, vol. 9th. of the Antiquarian Society, by Robert Riddell, Esq. of Glenriddell.

ground nearly level, but shelving a little to the South-west, about a quarter of a mile East of the little river of Urr, and nearly surrounded with eminences, or higher parts of the ground; in that respect was different from Cairns, two of which were situated on high tops, at only about three hundred yards distance, one on the North West, and the other direct East; but it rather partook of the site of the later burying-grounds, in being more sequestered and recluse. It was of the form of an oblong square or parallelogram, rounded at the corners, each of which lay to one of the cardinal points. The fence appeared to have been complete all round, except in the midst of the South-East side, where there was a breach of about five or six feet, that appeared to have been the entrance or door. There was no appearance of any other building of any kind, as the fence was the same throughout, and no fragments of mortar or other cement were to be seen.

It was constructed in the following manner: There were three rows of large stones so placed all round, that their centres were exactly three feet and a half distant from each other; the interstices were entirely filled up by smaller stones, of such a size, as a man could easily lift and throw to some distance with one hand. These small rounded stones were continued both on the inside and on the outside of the large ones for nearly three feet and a half,
so

so that the fence would have been pretty exactly fifteen feet broad all round. It appeared highest nearly above the most external circle of large stones, and gradually diminished in height as it approached the centre; at first it seemed doubtful whether the small stones were so situated from their having fallen down from a higher position; but there was reason to think they had been originally so, from their exact similarity in every part of the fence. Amongst the greatest part of the internal edge of the fence, there was a considerable quantity of fat earth, that run in below the small stones very near four feet, so as to approach the large stones, forming the innermost circle; it was divided into spaces of two or three feet wide, and nearly six feet long, by means of thin flat stones placed perpendicularly in the earth, and a pavement of the same stones was mostly found at the depth of from one foot and a half to two feet and a half from the surface. In the mould, small pieces of bones and of charred wood were at times met with; and in one place the fragments of a patera or urn were to be seen. Upon removing the stones near to where the entrance had been, three long pieces of iron were discovered, lying close together about the bottom of the fence, which, although the person who found them did not take notice of any particular inclosure constructed for containing them, must have been deposited in such a proper space, as they were of a great length, and

and all in the same direction with the middle line of the fence. They were in so entire a state, that the country people took them to a Smith, and got them hammered into instruments for country purposes, at the time that the Farmer who had found them was delirious from a febrile attack of which he died, and to whom I had given strict charges to preserve them in the most careful manner. In order to assist in describing the Cemetery and this Instrument, I made a rough sketch of the first on the spot, and the last I have figured from the recollection of myself and others, who had examined them.

Fig. 1st. represents a perpendicular section of the fence, being at a medium about three feet high above the ground, to shew the manner in which the large and small stones were deposited, and the earth divided by flat stones on the inside, together with the ditch, at present filled up with earth, but which is distinctly to be traced all round, nearly at an equal distance from the fence. A, B, C, the three rows of large stones exactly the same all round. E, the niche or space for sepulture. D, the portion of original till at the end of it, that must have prevented the ashes and bones, when mixed and covered with some earth, from falling into the ditch G; and F a section of the surface of the triangular hearth, as it appears near the South-west corner.

Fig.

* Fig. 2d. represents one of the branches of what may be called a Comburator;* three of them were found near the entrance, at the place marked A in the ground plan, Fig. 4th. They were in every respect alike, being rather more than seven feet long, of a straight stalk or pole, with an obtuse bend near their upper end, where they became broad and palmated to the full extent of three inches near the extremity, being concave in a small degree on the under side, and equally convex on the external or upper side, and where broadest, they were perforated so exactly with a perpendicular hole, that when applied together in a triangle, they could be retained firm in that posture by an iron pin, so as to put on the appearance of a truncated cone full seven feet high from the ground; see Fig. 3. When thus erected, their under ends stood at the angles of an equilateral triangle, about seven feet distant from each other, and when used, their upper ends, we must suppose, were secured by an iron pin, which was turned up below like a hook, as represented at A, and their under ends, from terminating in a point or pike, were stuck and secured in the hard till or
triangular

* N. B. The Fig. is rather too broad along the pole for its length.

triangular pavement.* Their general thickness was about an inch deep by half an inch broad, being deepest from the external to the inner side, so as to resist pressure best when made in that direction.

Fig. 4th, represents the general ground plan of the cemetery, being an hundred and eight feet wide over the fence, by an hundred and forty-eight long. A, the entrance at the south-east side. B B B B, the fence. C C C, &c. the divisions marked out by the thin flat stones set upon edge along the sides, but none at the internal ends of the divisions. These divisions, including the earth, were covered near two thirds of their length with the small round stones of the fence, and were not continued all round, but were deficient along the south-east side, and a little at the south corner. Upon digging up the surface in the middle, which was done at my desire, a triangular pavement of flat stones set upon edge, was discovered, about eight inches below the present surface, and nearest the south-west corner, as represented at E in the ground plan. Small pieces of charred wood, and some earth around the sides, of a fatter nature than usual, were got, that in part helped to fill up the ditch that went round the whole inside of the

F f

fence,

* The ends of the comburator, as represented in Fig. 3, are rather too much extended towards the pavement, and which is therefore of less extent than it ought to have been.

fence, and which must have been intended to preserve the sepulture from being affected with moisture. It may not be improper to remark, that the earth seemed to have retained its original height from the east side of the triangle to near the east corner, where there appeared something like the remains of a hearth, in a circular form, but which could not be with certainty ascertained; as many of the stones had been carried away at a former period from that part. See F on the ground plan.

Since my resolution to publish an account of the above, I have been informed of several inclosures in this country of a similar nature, particularly one about four miles south-east of Dumfries, in the parish of Caerlaverock, and two more between Drumlenerig and Sanquhar, at no great distance from the river Nith. The first I examined lately. It is situated in the midst of a piece of ground of the same height for a mile all round, except on the north-east side, where there is a declivity down to Locher Moss. It is a fence of the same nature and breadth with that above described, only a little more of earth mixed through the round stones: it encompasses a portion of ground that is at present ploughed up, of an exact elliptical figure, the largest diameter being an hundred and fifty-six feet by an hundred and twenty-six broad, with two branches in the enclosure, one on the north-east, which seems to have been the chief entrance, and another smaller on the south-east end. There is a continued
equal

equal depression of the ground towards the centre all round, so that it is hollowed like the palm of the hand : exactly in the middle there is a channelly piece of ground, where the corn and grafs seem to fail, and which in all probability was the hearth; so that in most respects it is very similar to that first described, only is a more perfect ellipse, is a little larger, and its largest diameter stands in exactly the opposite direction to the first.

A number of iron chains, hoops, &c. were discovered on ploughing the field on the north-east, where the declivity is continued down from the cemetery to the moss, and at no great distance from what appears to have been the principal entrance; they were concealed in a niche surrounded by flat stones, and covered over with them at the top; it was about three feet square, and no great depth below the surface. These iron instruments were discovered about four or five years ago, and were all deposited with Mr. Riddell, of Glenriddell, except a quantity of the links of the chains, that seemed totally destroyed by rust, and part of the hoops; these were not at all like what are intended to surround casks, but their greatest breadth being from the inner to the external side, appeared evidently intended to support a great weight; or rather being in that way capable to withstand more completely the action of fire. Three complete ones, with the fragments of two or three more, are still in Mr. Riddell's possession, together with the greatest part of the chains

and supports. He fortunately got a drawing made of them by the late Mr. Grose, soon after they came into his possession; now they are mostly mouldered away from exposure to the air, owing to their having been very much corroded by rust. With his permission I have got an exact copy taken from his, which is herewith sent; see the Figs. from 5th. to 15th. inclusive; they are of the same colour with what the chains, &c. were, when first discovered. They are of exactly the same size with Mr. Riddell's drawings, and are therefore on too large a scale in proportion to the others. The original large pillared support is about two feet long; each link of the chains extends about three inches and a half, and the others are in the proportion to these as represented. Besides these articles, the fork, and the hoops, there were three or four spades or shovels, of that kind formerly used in this country, having their edges only shoed with iron; the whole of their wood was mostly decayed. The use of these articles seemed to elude the ingenuity of every person that saw them, for several years, till the discovery lately of the triangle, hearth, cemetery, &c. makes every thing plain, so that now the complete apparatus seems to have been discovered for the purpose of consuming the dead by fire, and of depositing their bones and ashes thereafter. And what makes it still more remarkable is, the great distance of time that they have been preserved
undestroyed,

undestroyed, amounting perhaps to seven or eight hundred years.

The triangular space E, Fig 4th. appears to have been the hearth upon which the dead of the neighbourhood had been at one period burnt, by the fuel being built or heaped around the *comburator* and corpse in a triangular form, which it appears they had been very anxious to ascertain exactly, by having a space considerably larger than the comburator stood upon, marked out by the stone pavement,* so as to answer as a proper direction during that part of the ceremony. The corpse must either have been suspended by the head and shoulders, by means of the hoops and chains, so as to be in an erect posture, or must have been in the horizontal posture, as represented at Fig. 3d. The chains were most ingeniously contrived so as to allow of complete flexure in every direction, and to be shortened and lengthened at pleasure; see the Figs. of a link in different directions; Fig. 7th. Fig. 8th. and Fig. 9th. One of them could be with perfect ease added to or subtracted from the uppermost end, and still the last answered as a perfect hook or ring to hang the rest of the chain and the corpse by, which could be done, even at the time of the combustion,

by

* N. B. The ground plan, hearth, &c. having not been laid down geometrically, but only by the eye, so as to convey only an idea of the real situation of the different parts, the exact proportion is by no means preserved in the drawings.

by means of the iron fork, Fig. 5th. hooking and unhooking them. This fork might also have been used to throw any of the fuel, or any part of the body that might not be properly exposed to the action of the fire, into it again; and after any such parts had separated from the trunk, they might have been by that means laid hold of, and being secured by the chains or bent pieces of iron, represented at the bottom of Figs. 10th. and 11th. or stuck upon the points of the double hook, Fig. 10th. and then suspended by the ring, at its top, upon one of the large hooks at the bottom or top of the large support, Fig. 14th. so as to be completely consumed; and lastly, the fork might have been used for turning the whole corpse round, by making it revolve upon the pin at the bottom of the ring. See D, Fig. 14th. In the same manner we may suppose, when the head dropped off, which it would almost always do before it was completely consumed, it might have been supported in the iron ring, Fig. 15th. which seems to have had another support, opposite to the one by which it is at present suspended, and which in all probability was either hooked on at A, or at B, and which, by means of the two upper hooks C, and D, could be hung upon one or two of the hooks at the bottom or top of the support, Fig. 14th.

Figs. 6th. and 12th. seem part of one and the same instrument, for consuming the bodies of children, or those who were not heavy, by the three
hooks

hooks belonging to the three different branches, being introduced into three or more iron hoops that might have been put round the neck of the corpse; the middle of the body, and the middle of the thighs.* The shovels, that were found, may have been used for depositing the bones and ashes intermixed with earth, along the inside of the fence belonging to the cemetery, as already explained. It may also with probability be supposed, that according as the bones were more or less consumed, the niche in which they were deposited would be made larger or less, so as to contain them pretty accurately, which will account for their variety of size and shape, both in the cairns and cemeteries.

There is reason to believe, that wood only would be used for consuming the dead, and wherever any district became well inhabited, the wood would soon become scarce, from its use for that and other purposes; and therefore it would become necessary to fall on such means as above described, to prevent the necessity of so great a consumption of it as would otherwise take place.

The District in which the first described Cemetery is situated, was then probably well inhabited, for it is at no great distance from Knaer Castle, that is
said

* N. B. Of the three hoops that continue perfect in their circumference, one is sixteen inches diameter, one eighteen, and one twenty. There are also the remains of one or two still larger.

said to have been the feat of the independent Sovereigns of Galloway, which afterwards fell into the possession of the Baliols, Cummings, Douglasses, &c. It is upon the western banks of the Urr, about three miles south-east, and at half that distance between, is situated a very fine moat, perhaps the most perfect and largest in this part of the kingdom, from whence justice had been dispensed (sub sole) by the Reguli or their Deputies: it is called *Moat of Urr*.

The dependents and people would endeavour to be as near to their Chief's residence as possible, especially where the soil might be easily cultivated, as this District has always been.

We have certainly much reason to admire the ingenuity of our predecessors, in making use of a very simple machine (viz. the iron triangle) that would most effectually support their deceased friend, either in an erect posture, when flung by the head and shoulders, as if he had been standing as usual on the ground, and afford an opportunity to all his acquaintances of seeing him in the most proper posture for taking an interesting farewell. Or the corpse might be suspended in an horizontal posture, by means of the hoops, and those very ingenious chains and supports, in order to its being most completely exposed to the action of the fire where strongest, viz. from two to three feet from the ground; see Fig. 3d. so as the fire could act
with.

with sufficient force to consume it, with as little expence of fuel as possible.

Perhaps the triangular instrument, consisting of three equal parts, every way alike, and which could form only one complete support when joined, might have a reference to the doctrine of the Trinity, and thereby testify the deceased's firm belief of that point, and his hopes of salvation through that source.*

I think there can be but little doubt, but that the divisions on the inside of the fence, marked out by the lines C C C, &c. were distinct sepulchres of the bones, ashes, and remains of different people in the earth, instead of depositing them entirely amongst stones elevated above its surface, as in cairns; and if each division was appropriated to a single family, then this must have been the common cemetery of a considerable extent of country around.

This mode of sepulture can be best accounted for, from the inhabitants, after conversion, laying aside the ostentatious manner of burying their dead, on the highest and most conspicuous places, and

G g

from

* That the doctrine of the Trinity was soon canvassed in this country, is rendered probable from a tradition, that when St. Patrick wished to give the then uncultivated people of Ireland, and this country, an idea of it, he presented them with what grew every where under his feet, viz. a leaf of trefoil, or clover.

from an imitation of their neighbours, in committing the last remains of their friends to the earth, a little only under the surface; whilst they nevertheless retained, what was a favourite custom perhaps, that of causing the more corruptible parts to be dispersed in the air, and ascend towards heaven, by means of fire. And in the same manner they retained their mode of forming niches, or divisions, between the remains of different bodies, and of disposing of the stones nearly as they had been accustomed to do, in forming the tumuli, or cairns.

METEOROLOGICAL OBSERVATIONS *made on different*
Parts of the WESTERN COAST of GREAT BRITAIN:
arranged by T. GARNETT, M. D. *Physician at*
Harrogate.

[READ MARCH. 8, 1793.]

THE greatest part of the materials of which this memoir is composed, was put into my hands by my respected friend Dr. Percival: they had been communicated to him by several of his correspondents, but bad health, and a multiplicity of

of engagements, rendered it impossible for him to pay that attention to them, which he conceived they deserved: he therefore requested that I would arrange them, so as to form a Memoir for the Literary and Philosophical Society. This I have attempted to do, but must lament with the Society, that they want the useful observations and remarks, which they would have received from our worthy President. But though this is to be regretted, I trust that the facts will be deemed important, and that several useful deductions may be drawn from them. They belong principally to a part of the western coast of this island, situated between Dumfries and Lancaster; this part of the natural history of which, has hitherto been but little known. It is much to be wished, that the peculiarities of the climate in various parts of this island, were ascertained by similar observations, which would be an addition to its natural-history, not merely gratifying to curiosity, but applicable to the most useful purposes.

The remarks of Mr. Copland, of Dumfries, are very valuable; they are the result of attentive observation, assisted by a truly philosophic mind; and though some of the theories are perhaps not perfectly satisfactory, yet most of them are highly probable, and many perfectly new; upon the whole, his remarks contain the best and most rational rules for judging of the weather, that we possess. Whether or not they are all applicable to

every part of this island, similar observations made in different parts can only determine.

From the following observations it will be evident, that the quantities of rain are very different in different places; and though in the southern parts of the kingdom, much less rain falls than in the northern, yet it appears that this is not in proportion to the latitude of the place, but depends most probably on local circumstances. The annual mean, or average height of the rain which falls at Dumfries, deduced from the observations of seven years, is 34,658; the quantity which falls at Lancaster, calculated from observations made in the same years, is 40,3; while the average quantity which falls at Kendal, situated between these two places, deduced from the observations of five years, is no less than 61,2235.—This difference may probably be owing, at least in a great degree, to the high hills with which Kendal is surrounded, which form part of that ridge, not improperly called the English Apennine, which rises in the north part of Derbyshire, and running obliquely, nearly through the middle of the island, terminates in the Cheviot hills in Scotland. These hills being in the region of the clouds, solicit them effectually to deposit their moisture.

Were we possessed of the mean heights of the barometer in several parts of this island, both on the coasts and the inland parts, deduced from accurate observations, made for a considerable
number

number of years, we could, with tolerable accuracy, determine the comparative elevation of those different places above the level of the sea; some of which, from their gradual rising, are very difficult to ascertain, but which it would not only be curious, but highly interesting, to know.

In the 59th. vol. of the *Philosophical Transactions*, some experiments are related, by which it appears, that more rain is collected by a gage placed on the surface of the earth, than by another similar gage placed considerably higher. Mr. Gough's observations confirm this fact, since the quantity of rain collected by the gage at Kendal, is considerably greater than the quantity which fell upon Benson-Knott, situated 320 yards above the level of the town. This fact has engaged the attention of different philosophers, who have endeavoured to account for it, though in a manner not perfectly satisfactory. Dr. Percival's theory * is very ingenious, and undoubtedly the circumstances mentioned by him have their share in the production of this phenomenon, but Mr. Gough's account appears by much the most philosophical and satisfactory. It appears likewise from his observations, that this difference is less in summer than in winter, which he accounts for in a very ingenious manner.

I am now endeavouring to collect similar observations made on the eastern coast, and should I be
successful,

* See *Essays, Medical and Experimental*, vol. II. p. 85.

successful, I shall present them to the Society, previous to the publication of their next volume; in the mean time, I shall be glad to receive communications from any gentleman, who may have been in the habit of making such observations, or keeping journals of the weather.

State of the perpendicular height of the Falls of Rain, &c. at Dumfries, during the seven years preceding 1784, in inches and decimal parts. By Mr. Alexander Copland, Surgeon, at Dumfries.

	1777	1778	1779	1780	1781	1782	1783	Total in the same Months of each Year
January	2,255	2,700	2,566	1,103	1,662	6,288	3,812	20,386
February	3,083	1,538	2,624	3,467	3,411	3,477	4,458	22,057
March	2,976	2,631	0,719	4,923	0,294	4,409	0,822	16,774
April	3,015	1,639	2,664	4,149	1,895	1,384	0,097	14,933
May	1,509	3,856	3,624	3,954	0,749	3,780	2,207	19,619
June	3,540	2,280	2,732	2,569	1,458	3,257	2,931	18,767
July	1,698	3,665	5,217	1,067	2,509	1,804	2,787	18,747
August	3,410	2,663	1,704	1,172	6,545	4,149	3,121	22,764
September	2,478	3,467	8,311	6,611	1,432	5,113	4,493	31,908
October	6,110	6,741	5,624	7,309	0,479	3,900	4,812	34,975
November	3,646	5,500	1,003	3,399	5,121	1,316	3,261	23,246
December	0,940	5,674	4,347	0,307	4,433	2,041	1,193	18,935
Total in each year	34,749	42,354	41,135	40,033	29,988	40,918	33,994	Total Depth 263,171

Average of the annual falls for the seven years, commencing with 1777, is 37,596 inches.

The

The average of falls in each month during fourteen years, commencing with 1777, classed according to the seasons.

Spring.		Summer.		Autumn.		Winter.	
February	2,822	May	2,481	August	3,107	November	3,096
March	2,172	June	3,012	September	4,482	December	3,002
April	1,786	July	3,029	October	4,073	January	3,063
Mean falls in the Spring.	6,780	Mean falls in Summer	8,522	Mean falls in Autumn.	11,662	Mean falls in Winter.	9,161

Depths of rain which fell at Dumfries during the seven years following 1783.

		1784	1785	1786	1787	1788	1789	1790	Total
inches									Height
27,401									
	30,673	32,008	38,657	26,423	48,093	39,354	242,609		Inches.

Total

Total depths in corresponding months of the same years.*

Jan.	Feb.	March	April	May	June
Inches 22,493	17,455	13,630	10,082	15,052	23,412
July	August	Sept.	Oct.	Nov.	Dec.
23,668	20,735	30,844	22,042	20,097	23,099

The annual medium of falls, for the same seven years, is 34,658, and for the fourteen years, commencing with 1777, 36,127 inches.

Upon an average of the last seven years, the winds have blown in the following directions at Dumfries.

	North	N.E.	East	S.E.	South	S.W.	West	N.W.
Days	36	16	66	21	73	52	77	24

Taking the North and East winds in opposition to the South and West, they will stand as follows

	Days.		Days.
North	- 36	South	- 73
N. E.	- 16	S. W.	- 52
East	- 66	West	- 77
S. E.	- 21	N. W.	- 24
<hr/>		<hr/>	
Total of the North } easterly winds. {	139	Total of the South } westerly winds. {	226

BAROMETER.

* Mr. Copland had given the quantity of rain during these seven years, in each month, which fell in a square foot,

BAROMETER.

THE Barometer was the highest on the fifth day of January, 1789, being on that day 30, 9 inches, and on the 18th. of the same month it fell to 28, 05 inches, which was the lowest height during the preceding fourteen years.

The mean height of the Barometer, when placed about fifty feet above high-water mark, may be stated at 29, 85 during the summer half year, and from the beginning of September to the end of February, at 29, 75 inches.

THERMOMETER.

THE Thermometer was highest in the month of June, 1785, when it stood for four days running, about three o'clock in the afternoon, at 84° . and on the 26th. about the same hour, it was at 86° .—It was found to be lowest in January, 1784, when it stood for four following days at 11° . 12° . 14° . 14° . before sun-rise, and on the 25th. it fell so low as 8° . early in the morning.

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Average

foot, in pound, ounce, and drachm measures; but it was not thought necessary to reduce them to heights in inches, as the comparison may be easily carried on from the total depths in corresponding months.

Average, or mean heat during the seven years preceding January, 1791. The time of observation being always ten o'clock in the forenoon.

February	Average of heat	40 $\frac{1}{4}$	May	Average of heat	58 $\frac{1}{2}$	August	Average of heat	65 $\frac{1}{2}$	November	Average of heat	40 $\frac{1}{2}$
March	43	June	63 $\frac{1}{8}$	September	57 $\frac{1}{4}$	October	50 $\frac{1}{2}$	Mean heat of Winter.	December	38 $\frac{1}{4}$	
April	49	July	67 $\frac{1}{8}$	Mean heat of Summer.	62 $\frac{7}{8}$	Mean Autumnal heat.	57 $\frac{7}{8}$	January	34 $\frac{1}{4}$		
Mean heat of the Spring.	44 $\frac{1}{12}$								Mean heat of Winter.	38°.	

The medium of heat at Dumfries during the last seven years, at ten o'clock in the forenoon, is 50°, 8.

*Meteorological Observations and Remarks on the Weather
at Dumfries.**

THERE is reason to conclude,

1st. That the time when dry or wet weather may be expected throughout the year, is very uncertain in this country.

2d. That when the weather gets into a fixed state, or into particular sets of being either wet or dry, it does not appear to be disposed to change to the contrary on a sudden, but takes always some time, after the signs of fair weather or rainy have occurred, before it totally alters its disposition.

3d. That broken weather generally ends with very considerable falls in the internal and higher parts of the country, as the weather mostly settles immediately after a flood in the river Nith.†

4th. That the heaviest rains, when of long continuance, generally begin with the wind blowing
H h 2 easterly,

* These remarks were first published by Mr. Copland in the Dumfries weekly Journal.

† The sources and great body of the Nith come from a great distance, viz. from Ayrshire and its confines. There is often a great fall of rain at Dumfries, without the Nith being in any, or but a small degree affected by them.

easterly, when it gradually veers round to the south; and that the rain does not then begin to cease till the wind has got to the west, or rather a little to the northward of it.

5th. That it appears necessary for the cold which the atmosphere has acquired during the winter months of a severe season, to be thrown off, either by precipitations of hail or snow, or by its exertions upon the surface of the earth during the spring months, before it can take on a proper heat for spring or summer; hence proceed our backward springs; or if they are early, they are generally rendered abortive by some severe blast or storm about the end of the spring months; and therefore

6th. That spring and summer often commence at nearly one and the same time.

7th. That the coldest weather generally occurs when the wind is to the westward of the north, and not to the eastward of it, as has commonly been imagined.

8th. That however hot the external air may be in the day time, yet it is always temperate enough at night, having never been observed to elevate the Thermometer higher in this country at midnight than 66° . and seldom even so high as 60° .

9th. That the eclipses of the sun and moon generally occur in the midst of good weather.

10th. That great falls and stormy weather are more apt to take place on the third or second days before;

before, or the third, fourth or fifth days after the change and full of the moon, than at the precise time of these.

11th. That the disappearing or thorough solution of clouds in the night time, and particularly in winter, is always accompanied with an immediate increase of cold.

12th. That the formation of clouds or separation of watery vapour from the air, and the consequent falls of rain, snow, and hail, abstract the cold from the atmosphere, and precipitate it to the surface of the earth,* which causes the air to become warmer in the time of, and immediately after falls, than it was before; but when these are accompanied with lightning and other phenomena by which the inherent or latent heat is discharged from the atmosphere, the whole is rendered colder than at first.

13th. That when the wind blows over a space of country drenched with water or covered with snow; from the great evaporation thereby occasioned, a much greater degree of cold is soon produced: and when it continues to blow in such circumstances

* Mr. Copland seems here to speak of cold as a positive quality, but it accords better with our present ideas, to say, that on the vapours being condensed into clouds, rain, and snow, the heat which was chemically combined with them in a latent state, and preserved them in their vaporous form, is set at liberty, and thus causes an increase of warmth in the atmosphere.

stances for any length of time, though ever so moderately or slowly, the same effect follows; which is the chief reason why the air does not always become warmer after precipitations from it.

14th. That the barometer being lower, and continuing so longer than what can be accounted for by immediate falls, or stormy weather, indicates the approach of very cold weather for the season: and also, cold weather, though dry, is always accompanied by a low barometer, till near its termination.

15th. That warm weather is always preceded and mostly accompanied by a high barometer; and the rising of the barometer in the time of broken or cold weather, is a sign of the approach of warmer weather: and also if the wind is in any of the cold points, a sudden rise of the barometer indicates the approach of a southerly wind; which in the winter generally brings rain with it.

16. That streamers (*aurora borealis*) occurring for any length of time, or when very bright, are a sign that the atmosphere is undergoing a considerable change; and that either the vapours which floated in the superior regions can be no longer suspended by the electrical æther which adheres to them, and are therefore on their descent, which causes the aurora to be driven upwards to the still finer and higher regions, from the repulsion of the more firm and dense mediums below; or it is a real decomposition of the constituent parts of the atmosphere

in the superior regions, by which means its electricity is separated from the other parts, and by the stronger repulsion of the inferior and more condensed medium, is forced up in that waving lambent appearance we often see it.

17th. That soon after streamers have been considerable, either bodies of clouds are formed, or else a greater degree of cold is immediately produced.

18th. That the quicker streamers are in their motion, and the more they appear to be southward of the zenith, the sooner will a heavy body of clouds be formed, and in all probability a fall of rain, &c. ensue.—When they have been in that way considerable, as to extent and duration, the clouds begin to form with a precipitating appearance, generally in twenty-four hours after, and the fall takes place mostly before the end of thirty-six hours.

19th. That when they are of a deep orange or red colour, steady in their appearance, and confined to the north or easterly parts of the horizon, there is reason to expect a wind from the north or easterly points, and one or two days of dry weather, though cold for the season, before any fall takes place.

20th. That light or pale streamers are a probable sign of a south or westerly wind with a quick formation of clouds, &c. and when they appear, or flash and quickly disappear, in all the parts of the hemisphere, waving quickly with vivid colours, it

is a sign of strong winds, or of showers accompanied with gusts of wind.

21st. That the longer a fall has been indicated by streamers and a low barometer, not accompanied or followed by cold, without its taking place, the heavier and more continued it will be when it once commences.

22d. That thunder is the consequence of a very sudden and thorough change or decomposition taking place in the lower regions of the atmosphere, and consequently, that an immediate precipitation or fall will ensue, if the thunder is near, or a sudden change of the temperature of the air to cold.

23d. That the falling of the barometer may proceed from a decomposition of the atmosphere occurring around or near that part of the globe where we are placed, which will occasion the electricity of the atmosphere to be repelled upwards in fine lambent portions; or driven downwards or upwards in more compacted balls of fire; or lastly, to be carried along with the rain, &c. in an imperceptible manner to the surface of the earth: the precipitation of the watery parts generally very soon takes place, which diminishes the real gravity of the atmosphere, and also by the decomposition of some of the more active parts, the air loses part of that elastic and repulsive power which it so eminently possessed, and will therefore press with
less

less force on the mercury of the barometer than before, by which means a fall ensues.

24th. That the cause of the currents of air, or winds, may also be this way accounted for: and in very severe storms, where great decompositions of the atmosphere take place, this is particularly evident, such as occur generally in one or more of the West India Islands at one time, a great loss of real gravity, together with a considerable diminution of the spring of the air immediately ensues, hence a current commences, first in that direction whence the air has most gravity, or is most disposed to undergo such a change; but it being soon relieved of its superior weight or spring on that side, by the decomposition going on as fast as the wind arrives on the island, it immediately veers to another point, which then rushes in mostly with an increase of force; thus it goes on till it has blown more than half way round the points of the compass during the continuation of the hurricane. For in this manner these West India phenomena, as well as the alteration of the wind during heavy rains in this country (see remark No. 4) can only be properly accounted for.

25th. That the rising of the barometer may be accounted for by the watery vapour and other constituent parts of the atmosphere being thoroughly concentrated or combined together in the form of a real mixt, by means of the phlogiston, latent heat, or electricity communicated by the sun, fire on the

surface of the earth, &c. which act here, as on other occasions, like a bond of union among the other dissimilar parts, so that the air becomes not only more homogeneous, concentrated and heavier, but also may be supposed more elastic and repellent, and therefore will communicate a much greater pressure to the barometer.

26th. That when there is not a sufficient quantity of the principle of heat in the air, to form the vapour, &c. into a real mixt (which is chiefly the case in winter) the watery vapour enters in a state of solution into the air, if it continues suspended, and by dissolving in it, a greater cold is always produced. (See Remark 11th.)

27th. That when the watery vapour that has been in solution, separates itself from the air again, and floats about in the form of clouds, then the heat that was necessarily taken up in the solution of the vapour is set free, and gives a change of some more warmth to the temperature of the air.. (See Remark 12th.)

28th. That a high barometer may in like manner be said to indicate heat, and a low one cold, from the presence or want of a certain portion of heat or electrical fire in the air, which when in a large proportion must increase the warmth, solidity, and spring of the air, especially when by its presence a real mixture takes place. But when there is a deficiency of the principle of heat in the atmosphere, the watery vapour cannot be thoroughly combined,

combined, but only remains in a state of solution in the air, and consequently a greater degree of cold and diminution of the volume, and pressure or elasticity of the air, takes place. *

DUMFRIES, MAY 1st. 1791.

I SHALL now observe in addition to what is above stated, that after ten years farther experience, and comparing these observations with the natural occurrences of the weather, I have always found them sufficiently applicable, so far as general rules ought to be taken and admitted, on so uncertain a subject as the meteorological changes that are constantly going on in an island like ours: for when a patch of earth is situated like it in the midst of a great expanse of surrounding fluid, whose heat is nearly 45° . and at no time above three or four degrees higher or lower than that medium, whenever the atmosphere on that spot requires a heat considerably above that standard, it must soon be reduced to nearly the same temperature, by the action of the surface of the surrounding fluid on the inferior

I i 2

ferior

* The preceding remarks were inserted in the Dumfries Weekly Journal, published Sept. 25th. 1781.

ferior portion and surface of the air that is carried to the island by every wind.—For the same reasons the atmosphere comes to be loaded with the exhalations and vapour of this fluid or sea, which arriving with every wind on our island, easily accounts for the uncertainty of our weather and winds, and the frequency of falls.

In explanation of the 7th. and 8th. remarks it may not be improper to observe, that when the wind blows North by West, it must be loaded with the cold of the nearest frozen continent, viz. West Greenland, and at the same time takes the sweep of another bleak and almost uninhabited island, viz. Iceland, and will therefore bring along with it a greater quantity of frigorific particles than can be abstracted from it in passing over the intervening sea, and will approach the coasts of Scotland and North of England in a most bleak and cold temperature. In order to elucidate the 9th. and 10th. remarks, I shall observe, that when the Sun and Moon are either exerting their spheres of attraction in nearly the same line, or in a directly opposite situation, they must exert their influence in so uniform a manner upon our atmosphere and other fluids on the surface of this globe, as to keep up a more equal ballance, and give a greater degree of steadiness to the atmosphere, and prevent changes from taking place that otherwise must have occurred. But when the Moon has altered her position so far with respect to the Sun, that their attractions

attractions are exerted in oblique directions, the counterpoise is then entirely lost, so that changes and consequent precipitations will readily soon follow.—It may not be improper to observe, in addition to the preceding remark, that if a fall continues during an eclipse, or at the time of the change and full of the moon, it shows such a great disposition in the atmosphere to precipitation, as to overcome the steady influence of the Sun and Moon; and therefore a great deal of rain and broken weather may be expected, as I have often hitherto experienced. But in general, even when the weather is disposed to precipitations, it settles for twelve hours before, and twenty-four hours after the change and full of the moon.

It may, perhaps, be proper to make the following addition to the first part of the 15th. remark, viz. a high barometer is always accompanied by moderate weather as to wind, and is followed in the first place by warmer weather than what is the medium of the season; 2dly. by fair weather without precipitations; 3dly. by calm or moderate weather as to wind. It is also worth remarking, that a steady and strong wind blowing six hours or more from the southerly points, always drops the barometer, but from the northerly, always raises it.

That a real decomposition, or loss of substance in the air, occurs in the time of great falls, appears highly probable, when in addition to the phenomena narrated in remarks 23d. and 24th. it is observed,

observed, that the monsoons on the coasts of Africa and India, appear to be occasioned by the constant decompositions, or falls, continuing for several months together in the inland and mountainous parts of these continents; the air rushes in currents in all directions to the precipitating spot, in order to supply the loss of the volume, or real quantity of the air, from the decomposition constantly going on. It may indeed be said, that the air, by losing the vapour, loses only part of its weight, but none of its volume, and, by becoming more light and elastic, it mounts up to the superior regions, and runs back, in a contrary current, to fill up the deficiencies from whence the underloaded portions of the atmosphere came.

In the first place, this can never be demonstrated, and 2dly. probability is rather against it; for, in this country, the upper strata of clouds seldom go in a contrary direction to the wind below, but only for a few hours, till the inferior portion comes, by the friction and pressure of what is above it, to partake of this new impetus; discontinuing the direction in which the whole formerly proceeded, it soon follows the superior strata which always lead the way. Thirdly, in all great precipitations, it uniformly appears, that the current or impetus of the air is constantly accompanying the fall of the drops to the surface of the earth, and not upwards; so that a change of its position at the time it parts with its watery vapour, so as to become superior, and press
upon

upon the other parts which are disposed to undergo that change, seems on that account nearly impossible.

It may not be improper to observe, with regard to streamers, that their central point, to which they always tend, is not directly in our zenith, but about ten degrees to the southward of it; and that it is probable this deviation of the midst of the crown of the Aurora Borealis, may gradually diminish and disappear as we approach the equator, but will probably increase the nearer we are to the poles; and, also, that every different place may have its own Aurora Borealis, similar, though in most respects different from that of every other; in the same manner, that every place from whence the enlightened side of a precipitating cloud can be properly seen, has its own distinct rainbow at one and the same instant: and, therefore, that there is no occasion for streamers to be at such a prodigious height in the atmosphere, in order to be seen at once over a whole continent. For if the atmosphere is in exactly the same state of decomposition over all that extent, it will give the same appearance to observers at several thousand miles distance, at one and the same time. That streamers are often at no great height in the atmosphere, may be concluded from their appearing at times to the observer, to be between his eye and the tops of very high mountains, as I have more than once noted; and from their being frequently heard to make a hissing,
or

or jerking noise, which followed so quickly after the corruscations, that it was impossible they could have been elevated above two miles in height, and *seemed to correspond with their being only about one mile*; a remarkable instance of which occurred on the evening of the 6th. of January last, when they were audibly heard by many people, as well as myself, at the same instant, in and near this place.

*Meteorological Remarks in Westmoreland, by Mr.
J. Gough, of Kendal.**

EXPLANATION OF THE TABLE.

THE first column contains the year and month, the second the mean of the Barometer at Kendal, the third and fourth the mean of the Thermometer, and height of the rain at the same place: the fifth the rain at Waith-Sutton, the sixth that on Benson-Knot. The seventh expresseth the ratio of the rain

on

* Communicated by Mr. Gough in a letter to Dr. Garnett.

No.	Name	Age	Sex	Religion	Occupation
1	John Smith	25	M	Protestant	Farmer
2	Mary Jones	22	F	Catholic	Homemaker
3	Robert Brown	30	M	Methodist	Teacher
4	Elizabeth White	28	F	Baptist	Witch
5	James Wilson	35	M	Presbyterian	Merchant
6	Sarah Davis	20	F	Quaker	Homemaker
7	Thomas Miller	40	M	Anglican	Blacksmith
8	Anna Lee	18	F	Unitarian	Homemaker
9	William Clark	45	M	Episcopalian	Physician
10	Jane Adams	24	F	Presbyterian	Homemaker

Table of the population of the town of...

Continued.

Table of the population of the town of...

Table of the population of the town of...

Table of the population of the town of...

Table of the population of the town of...

Meteorological Observations at Lancaster, with Remarks on the same,
By Dr. Campbell, of Lancaster*.

Perpendicular Height of the Rain that has fallen at LANCASTER, during the last seven Years, in Inches and Lines; distinguishing each Month and Year.

	1784	1785	1786	1787	1788	1789	1790	Total in the same months of the foregoing years.	
	In	Li	I	L	I	L	I	L	
Jan.	28	1	26	0	17	1	21	0	22 5
Feb.	32	0	11	5	21	4	11	1	17 1
March	27	0	0	11	37	1	0	8	10 4
April	30	3	0	4	13	2	7	4	14 6
May	30	1	8	4	14	1	4	1	21 1
June	59	1	110	3	20	5	2	3	23 1
July	50	2	50	7	65	5	7	6	34 5
August	50	10	50	7	20	5	3	10	33 8
Sept.	27	5	7	11	20	3	7	5	31 2
Oct.	08	5	16	9	21	6	2	9	29 0
Nov.	30	0	30	4	5	1	4	6	25 4
Dec.	16	1	28	4	5	0	10	7	25 5
Total in each Year	371	16	323	51	611	29	45	51	Averages nearly 40.3-4-12

During a Thunder Storm in Aug. 1785, there fell at Lancaster near six Inches perpendicular of Rain one Afternoon.

Upon an average of seven Years the Winds have blown in the following Directions:

Days.	N. W.	N. E.	N. W.	S.	S. E.	S. W.	E.	W.	Mean Year.
30	67	26	51	35	92	17	47		

Taking the North and East Winds, in Opposition to the South and West, they stand as follows:

North	—	30	South	—	51
N. E.	—	67	S. W.	—	92
S. E.	—	35	N. W.	—	26
East	—	17	West	—	47
Days 149			Days 216		

(THESE TABLES ARE TO FACE page 265)

Mean Heat at LANCASTER, during the following Years.

Mean Heat of the same Months in the foregoing Years.

	1784		1785		1786		1787		1788		1789		1790				
	P. M.	10 P. M.	P. M.	10 P. M.	P. M.	10 P. M.	P. M.	10 P. M.	P. M.	10 P. M.	P. M.	10 P. M.	P. M.	10 P. M.		P. M.	10 P. M.
Jan.	34.	30.	41.19	37.18	38.22	36.18	41.12	39.13	41.8	38.10	36.14	34.17	42.	40.	Jan.	39.1	36.4
Feb.	37.19	33.7	36.13	32.7	40.17	37.	48.3	40.16	43.19	35.5	42.4	40.	46.17	43.	Feb.	41.3	37.3
March	42.	34.10	38.20	32.18	40.29	34.14	47.9	42.11	41.14	37.	36.18	34.15	46.	41.13	March	41.6	37.3
April	48.	40.17	52.16	43.12	54.5	44.4	47.9	46.2	50.	46.	48.10	42.18	47.15	40.6	April	50.	38.4
May	60.19	50.25	60.	50.	55.9	48.6	60.3	50.6	63.	51.16	59.5	52.	59.	50.20	May	59.3	39.3
June	62.	53.6	68.8	56.19	68.4	56.1	66.	55.21	59.	50.	67.	55.	63.6	54.	June	64.5	54.4
July	64.18	55.24	66.9	57.15	63.3	56.1	61.	55.	62.12	55.	68.7	60.	65.12	54.21	July	64.1	56.
August	62.18	53.22	60.8	53.19	63.11	56.23	60.7	52.	60.10	55.	59.	54.23	58.10	51.	August	63.2	55.5
Sept.	64.17	55.21	60.	53.7	64.18	47.	44.	55.22	47.15	55.6	47.16	50.	46.	49.	Sept.	59.4	53.1
October	51.15	44.	49.11	41.20	37.	37.26	46.20	38.	46.	42.	44.	38.14	46.6	41.	October	52.1	40.2
Nov.	45.	40.21	45.17	38.11	38.11	36.19	42.22	38.8	35.8	30.19	46.	43.	40.	38.	Nov.	45.5	39.5
Dec.	35.	31.	39.1	36.15											Dec.	39.2	30.2
Mean Heat	50.8	43.7	51.6	44.11	50.6	44.1	53.	46.5	51.10	45.9	51.7	45.5	52.9	46.5	Mean Heat	51.8	45.6

Mean Heat of seven Years, Noon and Night. 48.7

Highest Degree — 82
Lowest — 18

DEPTH of RAIN fallen in SALFORD, during the Year 1792.*

	Inches.	Rain or Snow.		Inches.	Rain or Snow.
January	2	19 Days	July	3.75	24 Days
February	2	16	August	6.25	18
March	2.75	24	September	9	26
April	2.5	16	October	4	17
May	8	26	November	2	12
June	3.5	24	December	9.5	26
	20.75	125		34.5	123
				20.75	125
	Inches 55, 4			248 Days Rain	

Barometer.

Highest Feb. 17, 30.25
Lowest Sept. 21, 28.8

Fahrenheit's Thermometer. No Aspet.

January 19—8m.—19°. Wind N. E.
April 13 42.—68. — East.
April 10 In sun shine 104°.

* Communicated by George Walker, Esq. to Dr. Percival.

on the Benson-knott to that at Kendal, the latter being denoted by unity. This column is added because it was not always convenient to examine the upper gage on the last day of the month.

Month.	Mean of Barometer.	Mean of Thermometer.	Rain at Kendal.	Rain at W. Sutton.	Rain at Benson-knott.	Ratio.
1787.						
June	29,87	—	3,6422			
July	29,78	59,00	5,5549			
August	29,94	58,70	5,4598			
Sept.	29,94	52,20	2,2260			
Oct.	29,63	45,60	8,8750			
Nov.	29,75	37,30	4,5311			
Dec.	29,64	36,20	4,8973			
1788						
Jan.	29,96	37,10	5,8230			
Feb.	29,48	36,70	3,2115			
March	29,58	36,10	3,1640			
April	29,94	45,74	4,1676			
May	29,98	52,30	1,2919			
June	29,93	56,78	2,5497			
July	29,81	56,50	7,7361			
August	29,838	55,90	3,2919			
Sept.	29,745	52,78	5,6970			
Oct.	30,078	44,60	2,3479			
Nov.	29,977	40,40	3,4286			
Dec.	29,927	30,00	1,0093			
1789						
Jan.	29,581	32,90	6,9036	5,32		
Feb.	29,498	36,93	9,2058	6,77		
March	29,684	33,90	1,1532	0,53		
April	29,640	42,74	4,5294	3,42		
May	29,780	52,90	5,5618	3,84		
June	29,768	56,30	4,2358	3,86		
July	29,750	58,70	5,2164	6,71		
August	29,996	60,90	1,4856	1,32		
Sept.	29,757	52,70	5,8674	4,64		
Oct.	29,578	45,80	6,4230	6,90		
Nov.	29,610	38,60	6,2496	5,40		
Dec.	29,63	41,50	3,9380	9,25		

Month.	Mean of Barome- ter.	Mean of Thermo- meter.	Rain at Kendal.	Rain at West Sutton	Rain at Benfon- knott.	Ratio.
1790.						
Jan.	29,915	37,90	6,8424	4,99	—	—
Feb.	30,074	41,60	3,6744	2,04	1,32933	,343
March	30,187	40,43	1,5240	1,05	,8843	,580
April	29,864	41,30	2,2320	1,42	3,0192	1,603
May	29,87	52,50	2,4612	1,92	2,3173	,942
June	29,91	56,70	3,9786	6,10		
July	29,73	55,95	7,6848	7,41		
August	29,82	56,50	6,3450	5,69		
Sept.	29,89	50,70	6,7056	7,50		
Oct.	29,81	47,40	4,8636	4,30		
Nov.	29,75	38,90	5,0142	4,75		
Dec.	29,72	35,80	9,8154	7,10	1,9264	,196
1791.						
Jan.	29,325	37,90	8,0316	6,85	1,4871	,213
Feb.	29,820	37,10	6,2118	4,34	1,8098	,247
March	30,050	41,00	3,4140	2,88	,9428	,276
April	29,700	46,20	4,5852	4,67	2,6520	,545
May	29,936	49,57	4,2006	4,06	1,5282	,363
June	29,890	55,70	3,2562	1,62	1,4668	,440
July	29,740	58,10	6,1944	5,43	3,8664	,616
August	29,960	57,50	4,8342	4,98		
Sept.	30,040	53,80	3,0420	2,27		
Oct.	29,600	45,80	5,1720	4,19		
Nov.	29,55	40,80	6,5822	4,40		
Dec.	29,49	31,56	7,8372	4,48		
1792.						
Jan.	29,59	33,80	3,7614	3,13		
Feb.	29,84	38,95	5,3622	3,97		
March	29,60	40,00	6,4854	4,37		
April	29,789	46,88	10,0295	7,44		
May	29,865	49,50	6,3036	5,77		
June	29,855	55,00	3,6486	2,32		
July	29,792	58,86	5,7102	7,19		

Gage on Benfon-
knott destroyed.Gage
destroyed.

REMARKS.

REMARKS.

This is a correct table of the abstract of my observations, on the meteorology of Westmorland. The mean height of the Barometer at Kendal, collected from the observations of five years, beginning July 1787, is 29,7845. The mean of the thermometer, at the same place, for five years, beginning July, 1787, is 46,08. The annual mean height of the rain, for an equal period, is 61,2235. It will be necessary after what has been stated above, to say something relative to the situation of the town.

It is placed on the west side of a long valley opening to the S. W. Benson-Knott, on which a rain gage has occasionally been placed, stands about two miles N. E. of the town, and is the highest ground in the neighbourhood; its elevation above the river appears to be nearly 320 yards, by barometrical measurement. The height of the town, above the ocean, is 66 yads, calculated from the same principles, that is, from the same barometrical mean specified above; but, in all probability, does not exceed 40 yards; consequently Benson-Knott, on the latter supposition, rises 360 yards above the same level. The distance of the nearest sea does not exceed 30 miles, from which an estuary called Kent-sands, advances to within five miles of Kendal. It is manifest from the last column in the table, that the comparative quantity of rain on the hill, is

less in winter than in summer. The fact is supported by the experiments of two successive years, both of which were favourable to the inquiry, because little snow fell in either season; but though it would be rashness to maintain that the law is fairly established, yet the following circumstances argue strongly for the truth of it. The mean height of the thermometer in wet weather, in winter, is nearly 46° . that is 8° . above the freezing point. Now if we allow that the temperature diminishes half a degree with every 200 feet of elevation, with Mr. Kirwan, the mean height of the point of congelation will be 1066 yards, from which if we subtract 320, the height of the hill, there remains 746 for the length of the column of air, that affords the rain collected by the upper gage in winter. On the other hand, the mean height of the thermometer in wet weather, in summer, is about 54° . consequently, the length of the column that supplies rain to the upper gage in the warmer part of the year, is 2613 yards, and the mean height of the point of congelation is 2933: but the ratio of 1066 to 746, is greater than that of 2933 to 2613; and as no rain can be formed above the point of congelation, it follows from induction, that when the ratio of the columns that supply the upper and lower gages is least, the quantities collected by them will approach the nearest to equality, and the contrary.

This inclination agrees well enough with the remarks in the table, when a proper allowance is made

made for showers which fall very partially in mountainous countries. In April, 1790, a heavy shower fell on the upper gage, while the water received by that in the town was very trifling. This accounts for the strange deviation from the general rule observable in the notes for that month.

The annual mean height of the rain at Waith-Sutton, for three years, beginning January 1789, is 54.13; the ratio of which is to that of Kendal, for the same time, as 0.82 to 1. If the ratios of the three winter months, December, January, and February, and of the three summer months, June, July, and August be taken, the former will be as 0.71 to 1; and the latter as 1.001 to 1, a phenomenon that cannot be explained clearly from any thing we know at present, yet the fact is certain, because the ratios are determined from long periods. Is it that the air is more powerfully solicited in winter to deposit its water, by approaching the hills, than it is in summer? The idea is a mere conjecture, but the comparative situations of the two places does not afford a better. Waith-Sutton lies about seven miles S. W. of Kendal, and about three miles from the estuary before mentioned; its height above the high-water mark of the tide, does not exceed five or six yards: the country about it being flatter and more open, than it is a few miles farther north.

Tarlton-Knot, about a mile and a half south east of it, is the only hill of note in the neighbourhood; it is a high, barren rock of lime-stone.

The

The general conclusions contained in these remarks, are established on the means of the different observations, which is the true way of reasoning on the subject.

FELLFOOT RAIN GAGE. *

1788.	In. Pts.	1789.	In. Pts.
January	5,80	-	5,71
February	4,06	-	8,59
March	4,34	-	3,38
April	3,95	-	4,11
May	1,25	-	6,25
June	2,96	-	4,93
July	6,77	-	5,92
August	3,24	-	1,38
September	4,44	-	4,18
October	2,61	-	7,77
November	2,15	-	5,18
December	0,49	-	9,12
Total	42,06	Total	66,52

1790.

* Communicated to Dr. Percival by Lord George Cavendish.

1790.	In. Pts.	1791.	In. Pts.
January	5,61	-	6,83
February	2,56	-	5,13
March	1,38	-	3,21
April	0,93	-	4,76
May	3,78	-	3,73
June	4,50	-	1,29
July	5,75		
August	7,43		
September	6,82		
October	5,37		
November	5,76		
December	8,59		
Total	<u>58,48</u>	Total	<u> </u>

Depth of Rain which fell at Salford, communicated
by Mr. Geo. Walker.

1790.	In. Lines,	1790.	In. Lines.
January	2 3	July	5 9
February	1 3	August	4 6
March	1 0	September	3 9
April	2 3	October	2 9
May	3 3	November	3 3
June	5 6	December	7 3
	<u>15 6</u>		<u>27 3</u>
			<u>15 9</u>

42 $\frac{1}{4}$ Inches.

I have not received the account for 1791.

J. G.

1792.	Inches.	Rain or Snow,
January	2	19 Days.
February	2	16
March	2,75	24
April	2,5	16
May	8	26
June	3	24
<hr/>		
	20,25	125

1792.	Inches.	Rain or Snow.
July	3,75	24 Days.
August	6,25	18
September	9	26
October	4	17
November	2	12
December	9,5	26
<hr/>		
	34,5	123
	20,25	125

Inches 54 $\frac{3}{4}$ 248 Days.

	Barometer.	
Highest	Feb. 17th.	30,25
Lowest	Sep. 21st.	28,8

Farenheit's Thermometer, North Aspect.

Jan. 19, 8 morning, 19°. wind N. E.
 April 13, 4 P. M., 68 East.

April 10th. in the Sunshine 104°.

Meteorological

REMARKS.

From the foregoing tables it appears, that the summer months are not only much hotter about London than at Lancaster; but that the spring is considerably earlier: the mean heat of the month of March at 2 o'clock in the afternoon in Pall Mall, being, from the observations of Dr. Heberden, 50° . whilst with us, the mean heat of the same month, at the same hour, is only $41\frac{1}{2}$.

The excess of heat about London in the summer months, proceeds as much from having less rain, as from a more verticle sun; and accounts for the ripening of fruit sooner there, and in greater perfection than with us. Were our atmosphere less loaded with moisture, the heat at Lancaster would be amply sufficient for the purpose; as the thermometer placed in the shade with a northern aspect, frequently stands in fine summer days, at from 70 to 80° . But the great quantity of rain which generally falls during the months of July, August, and September, chills the air, and occasions our fruit (especially peaches

L1

and

Fell-Foot (mentioned in the preceding page) lies at the south end of Winandermere, where the lake contracts into a river; the acclivities of the inclosing hills are steep, but more so on the east side.

and nectarines) to ripen late, and with little flavour. So that our climate still preserves the character given it by *Tacitus*, in his life of *Agricola*: *Cælum crebris imbribus ac nebulis fœdum*.

The same circumstances operate to the disadvantage both of our hay and corn harvests; which last frequently receives essential damage before it can be housed. It has been an old observation in this country, that those who get their hay early, generally get it well; and we see a very good reason, because upon an average, nearly one third more rain falls in July than in June. This seems to shew that an attention to the cultivation of the early grasses, might be productive of considerable advantages, not only by ensuring a larger crop of after grass, but by having a greater chance of fine weather for getting in the principal crop of hay. *Mr. Curtis*, in his observations on British grasses, enumerates and recommends six kinds of early grasses. The first four of them seem best suited to our purpose, viz. the *Anthoxanthum odoratum*, *Alopecurus Pratensis*, *Poa Pratensis*, and *Poa Trivialis*. His fifth grass, the *Festuca Pratensis*, is the principal grass in our best mowing grounds; this he puts down as producing its flowering stems near London about the middle of June, but it is seldom in that state here before the first week in July, whilst the others are ripe a fortnight or three weeks sooner.

This excess of rain, however, which operates to the disadvantage of the ripening of corn and fruit, occasions a more constant verdure in our pasture fields, in the

the summer, as well as a more copious crop of after-grass than they have in the southern parts of this island; and points out the superior excellence of this country for the purpose of grazing. The natural advantages which it possesses in this respect, have perhaps given rise to that fine breed of horned cattle, for which Lancashire has always been famed.

The relative wetness and dryness of the different months, appears to be in proportion to the amount of the rain that has fallen in the same months of the several years. I am, however, inclined to think, that upon a longer observation the month of August will not average so much rain; as it now stands so high, owing to a thunder shower in the year 1785, when near six inches perpendicular fell in the course of a few hours. It was by far the heaviest rain I have seen, and its influence was not extended many miles south of the town.

Among the papers which I received from Dr. Percival, is a register of the wet and fair days for 18 years, beginning with 1769; by Mr. John Poole, of Rhodes, five miles north-eastward of Manchester, on the Rochdale road. In this register is put down the number of wet and fair days in each month during

the 18 years above-mentioned ; but I think it will be sufficient to insert the result of each year :—

Year.	Days Rain,	Days Fair.
1769	229	136
1770	246	119
1771	205	160
1772	203	163
1773	182	183
1774	192	173
1775	211	154
1776	192	174
1777	203	162
1778	215	150
1779	184	181
1780	173	192
1781	191	174
1782	239	126
1783	182	183
1784	154	212
1785	181	184
1786	198	167

It is evident from this table, that the average for 18 years is $166\frac{5}{18}$ days fair, and $198\frac{8}{9}$ days rain.

After the preceding essay was finished, I received the following letter from Mr. Copland, which as it contains

contains several useful and interesting remarks, I shall take the liberty of inserting here.

Dumfries, Jan. 15, 1793.

SIR,

I was informed by a letter from Dr. Percival about six weeks ago, that my meteorological states and remarks, with those of several others, had been transmitted to you for your perusal and arrangement. I have now had near two years longer time to reflect on them, and have not as yet seen reason to alter any one of them entirely. No doubt some of them may be judged unnecessary; and the arrangement and dress they appear in may be reckoned improper; but it should be remembered that they were originally intended for a newspaper, and were in no respect altered from that order, which I now regret.

There is one, viz. that the barometer is a most certain indication of heat and cold, however imperfect it may be with respect to wet or dry weather, which I believe is my own.

Through the whole of the winter preceding the present, I was attentive to the changes and alterations of the weather, and found that not one from cold to moderate weather, and vice versa took place without its being sufficiently pre-indicated by a conspicuous rise or fall of the barometer; and I believe no winter was more completely varied either in temperature or falls. There was an instance of a free thaw with a
northerly

northerly wind, and a hard frost with a south-west one, for near twenty-four hours each, which could only be accounted for from the first being preceded by a high barometer, and the latter by a low one.

I am now convinced that the altitude of the barometer, as it recedes from the medium of the month, must be followed by certain consequences, which can be reduced to a matter of calculation, and depended on perhaps with more than moral certainty.

Every remarkable elevation of the barometer, where it is of any duration, is followed by very warm or by dry weather, and moderate as to wind, or by all of them; but *heat* seems to have most influence and connection; and when it is deficient, the continuance of the other two will be the longer and more remarkable; therefore the calculation must be in a compound ratio of the excess and deficiency of the heat, and of the dryness of the weather in comparison of the medium of the season; and with regard to the want of strong wind, it appears to be intimately connected with the last, as they shew that no precipitation is going on in any of the neighbouring regions: perhaps a reason for this will appear on consulting my former remarks, No. 24th.—You will therefore find every remarkable situation of the barometer which is calculated in the inclosed states, for each month, answered by a corresponding aberration from the medium as to temperature, taken together with the greater or less quantity of falls; and if it is not fully
answered

answered in the same month, it is always sufficiently attuned for in the one that follows; two instances of which may be seen in January and February, 1791, and in April and May, 1792.

Some farther extensions of these mediums might be made out in the states, particularly with regard to the thermometer, but my time would scarcely permit me to complete the one for the year 1792 in the form you see it. I thought it unnecessary to transmit the one for the year 1791 till I could send you both, as the year was so near a close; you have therefore both inclosed.

I also think another remark may be added to those formerly sent, viz. that where two water-gages are kept, the one higher than the other, where the quantity in the lowest *very much* exceeds that of the high one, it is a sign that the fall will be of some continuance, but where the quantity in the highest is equal to, or even exceeds, in a small degree, the lower one, which is sometimes the case, it is a sign that the bad weather is over, or nearly so, and dry weather for a few days may be expected*.—There is a difference of

* This fact observed by Mr. Copland, may be easily accounted for, because when the quantity in the lower gage very much exceeds that in the higher one, it shews a strong disposition in the whole atmosphere to deposit its moisture, and consequently bad weather may be expected; but when the quantity in the higher is nearly equal to, or exceeds that in the lower gage, it shews the atmosphere to have been in
a state

of six feet in the altitude of my gages, and they are 12 feet distant from each other.

I shall be glad to hear from you when convenient, and am,

SIR,

Your most obedient and humble Servant,

ALEX. COPLAND.

To Dr. Garnett,

Harrogate.

a state of momentary decomposition at a considerable height above the gages, and not disposed to a precipitation near the surface of the earth.

First. The quantity and corresponding perpendicular height of rain, &c. fallen at Dumfries during the year 1792, as measured daily at ten o'clock by lb. oz. and drachm measures.—Secondly. The medium height of the Barometer taken at the same time, compared with the medium of each month during the last fourteen Years.—Thirdly. The medium height of the Thermometer in each month of 1792, taken and compared in the same manner.

	Falls in a Water Gauge of one Foot Square.					Barometer.				Fahrenheit's Scale Thermometer.			
1792	Quantity of Rain.	Corresponding height of falls.	Above the Medium.	Below the Medium.	Medium for each Month for 15 preceding years.	Medium of each Month	Above the Medium.	Below the Medium.	Medium in each Month for five years.	Medium in each Month in 1792.	Above the Medium.	Below the Medium.	Medium in each Month for five years.
Months	lb. ozs. drs	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Degrees.	Degrees.	Degrees.	Degrees.
January	13 13 6	3.1801	.0909		3.0892	29.528	.0488		29.4792	35.056	.137		35.819
February	14 1 1	2.8214		.0172	2.8386	29.792	.1536		29.6384	41.896	1.3206		40.5754
March	21 1 1	4.2242	2.1973		2.0269	29.475		.2432	29.7182	44.290	.750		43.540
April	20 10 1	4.196	2.3243		1.8717	29.739	.548		29.6842	52.860	3.094		49.106
May	22 0 3	4.404	2.0543		2.4397	29.786	.0052		29.7931	56.5625		1.5827	58.1452
June	13 0 0	2.6668		.3918	2.9966	29.702		.0822	29.8397	60.439		2.054	63.393
July	22 2 4	4.4429	1.2660		3.1769	29.702		.1262	29.8282	65.220		1.3538	66.5798
August	20 9 6	4.1326	.9956		3.1370	29.797	.004		29.861	60.619	1.2161		65.2929
September	26 10 2	5.342	1.0583		4.2837	29.562		.262	29.824	56.133		2.2714	58.4044
October	23 3 6	4.659	.55		4.1090	29.702	.0244		29.6776	49.903		.2804	50.1834
November	13 6 6	2.617		.5937	3.2107	29.82	.2377		29.5823	46.70	5.0804		40.8910
December	23 14 6	4.797	1.7652		3.0318	29.579	.027		29.552	39.613	2.020		37.593
Total throughout the Year.	236 512 1	47.5130	11.2992		36.2138			.2461		51.3364			50.7960

Amount of the Falls in each Season throughout the Year 1792, compared with the Medium for the preceding fifteen Years during the same Seasons.

	Inches	Above the Medium.	Below the Medium.	Medium for 15 Years.
In Spring the depth of falls was	11.2416	4.4808		6.7608
In Summer	11.5437	3.0037		8.5400
In Harvest	14.1336	2.5395		11.5941
In the 3 winter months	10.5941	1.2752		9.3189
Throughout the year.	47.5130	11.2992		36.2138

Barometer highest Anno 1792, April 30th. it stood 30.55. and lowest January 13th. it was 28.7.—Thermometer highest August the 15th. 79°.—Lowest January 13th. before sun-rise, 16°.

Number of Days the Wind has blown from the different principal points throughout the Year 1792.

North	North East.	East.	South East.	South	South West.	West.	North West.
Days.	Days	Days	Days	Days	Days	Days	Days
35½	19	7½	23	95	47	48	27

Taking the North and Easterly Winds in Opposition to the South and Westerly in this Year, 1792, compared with the Medium of the eight preceding Years, they will stand as follows:—

	Above the Medium	Below the Medium	Medium for years.		Above	Below	Medium.
North	35½		36.25	South	95	21.25	73.75
North East	19	3.94	15.06	South West	47	5.12	52.12
East	7½	5.44	68.06	West	48	29.69	77.69
South East	23	3.79	19.81	North West	27	2.75	24.25
Total	149.	12.42	137.18	Total of S. W. Winds	217	10.81	227.81
					149		

Prevalence of the South-West Winds, 68 Days in 1792.

Fifth. The quantity and corresponding perpendicular height of rain, &c. fallen at Dumfries during the year 1791, as measured daily at ten o'clock by lb. oz. and drachm measures.—Secondly. The medium height of the Barometer taken at the same time, compared with the medium of each month during the last fourteen Years.—Thirdly. The medium height of the Thermometer in each month of 1791, taken and compared in the same manner.

[To face Page 272.]

Falls in a Water Gauge of one Foot Square.						Barometer.				Fahrenheit's Scale Thermometer.			
1791	Quantity of Rain.	Corresponding height of falls.	Above the Medium.	Below the Medium.	Medium for each Month for 14 preceding years.	Medium of each Month in 1791.	Above the Medium.	Below the Medium.	Medium for the four preceding years.	Medium in each Month in 1791.	Above the Medium.	Below the Medium.	Medium of the four preceding years.
Months	lb. ozs. dis.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Degrees.	Degrees.	Degrees.	Degrees.
January	17 74	3.5028			3.0628	29.2082		3.388	29.547	40.098	5.348		34.750
February	15 40	3.0073	.745		2.8223	29.7922	.1922		29.600	41.0772	.8272		40.250
March	9 83	1.0096		.2621	2.1717	29.9712	.3412		29.630	45.702	2.702		43.000
April	15 11	3.0002	1.2734		1.7868	29.6613		.0287	29.690	40.530	.530		49.000
May	10 46	1.8642		.6166	2.4808	29.8203	.0353		29.785	46.726			58.500
June	8 07	1.6903		1.3225	3.0128	29.8747	.0437		29.831	64.304	1.214		67.150
July	26 20	5.2386	.2092		3.0296	29.0570		.2140	29.8710	64.209		2.8509	67.150
August	17 115	3.5545	.4474		3.1071	29.8851	.301		29.8550	64.4643		1.0357	57.500
September	7 80	1.5039		.29784	4.4823	29.0120	.235		29.777	61.022	3.272		50.500
October	28 00	5.6285	1.5550		4.0726	29.568		.137	29.705	48.917		1.5083	40.500
November	24 04	4.8185	1.7226		3.0959	29.4915		.1035	29.605	42.4582	1.9582		40.500
December	17 26	3.4433	.3731		3.0024	29.414		.173	29.587	32.906		5.784	38.750
Total throughout the Year.	1961 05	39.2817	3.1546		36.1271								

Amount of the Falls in each Season throughout the Year 1791 compared with the Medium for the preceding fourteen Years during the same Seasons.

	Above the Medium.	Below the Medium.	Medium for 14 Years.
In Spring the depth of falls was	8.0371	1.2371	6.780
In Summer	8.7931	.2711	8.522
In Harvest	10.6869		11.6600
In the 3 winter months	11.7646	2.6015	9.1631
Throughout the year.	39.2817	3.1566	36.1251

Barometer highest Anno 1791, March 8th, it stood 30.6, and lowest January 4th, it was 28.45.—Thermometer highest June the 6th, 80°.—Lowest December 11th, at ten at Night, 12°.

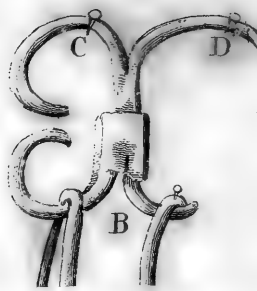
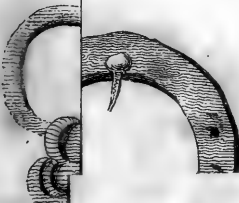
Number of Days the Wind has blown from the different principal points throughout the Year 1791.

North	North East.	East.	South East.	South	South West.	West.	North West.
Days	Days	Days	Days	Days	Days	Days	Days
38	81	66½	111	79	53	82½	26

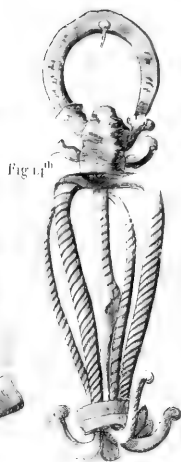
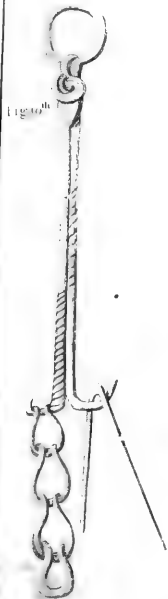
Taking the North and Easterly Winds in Opposition to the South and Westerly in this Year, 1791, and compared with the Medium of the seven preceding Years, they will stand as follows:—

	Above the Medium	Below the Medium	Medium for 7 years.		Above	Below	Medium.
North	38	2	36	South	79	6	73
North East	81		16	South West	53	1	52
East	66½	1	66	West	82½	5½	77
South East	111	91	21	North West	26	2	24
Total	124½	14½	139	Total of S. W. Winds	240½	14½	226

Prevalence of the South-West Winds, 116 Days.



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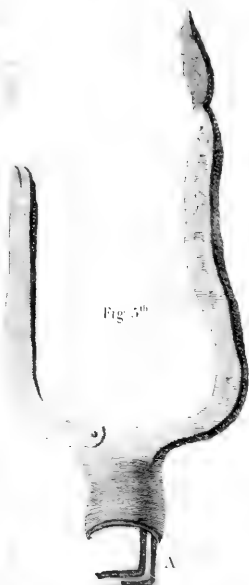


Fig. 5th

A

*of the same size as here delineated
A Piece of the Oakon Handle*



Fig. 7th

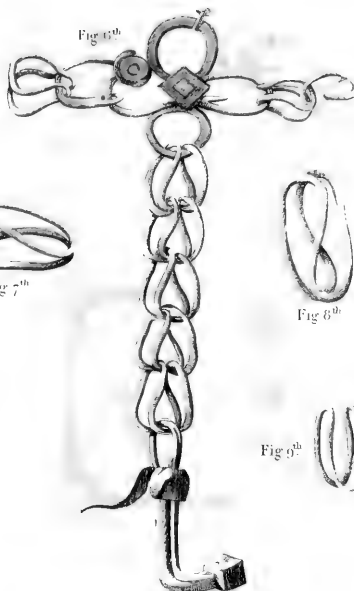


Fig. 6th



Fig. 6th



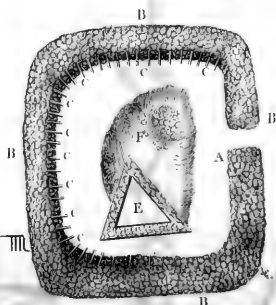
Fig. 9th



Fig. 1st



Fig. 4th



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VOL. IV.

PART II.

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1. The first step is to identify the problem or question that needs to be answered. This involves understanding the context and the specific requirements of the task.

[Faint, illegible handwritten notes]

The first of these is the fact that the
 government has been unable to raise the
 necessary funds to meet its obligations.
 This is due to a number of factors, including
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The LAWS of MOTION of a CYLINDER, compelled by the repeated Strokes of a FALLING BLOCK to penetrate an OBSTACLE, the Resistance of which is an invariable Force. By Mr. JOHN GOUGH.—Communicated by Dr. HOLME.

NO practical benefit is to be expected from the following Essay; for, though the idea is evidently borrowed from the Pile-engine, yet the operations of this Machine are so much embarrassed by friction and other irregular forces, that it would be absurd to compare its effects with the conclusions contained in the present Paper: the Piece is purely speculative, and exhibits a few mathematical truths, which perhaps may afford some amusement to those, who are partial to such inquiries.

PROBLEM I. If a Cylinder of hard matter rest with one of its ends upon the horizontal surface of an obstacle, whose resistance is a constant force, it is required to determine by means of the following

M m

Data,

Data, from what point above the top of the pillar a falling Body shall repeatedly descend, so as to be just able to drive it intirely into the obstacle by a given number of strokes. DATA. Weight of the block $= a$, height of the Cylinder $= c$, its specific gravity $= d$, area of its base $= e$; lastly, let it be known from experiment, that if a column of the same matter, whose height is f , and base g , be projected against the same obstacle, with the velocity n per second, it will penetrate it to a depth r .

SOLUTION. Let q $=$ the weight of a cubic foot of water, $s = 16\frac{1}{2}$ feet; y $=$ the given number of strokes; and x $=$ the required distance; then the weights of the two Cylinders are $= dqce$ and $dqfg$. Now, if a body in motion be resisted by a constant force, the space described by it, till its motion is destroyed, is as its quantity of matter and the square of its initial velocity directly, and as the resisting force inversely; therefore, when the quantity of matter and velocity are given, the force is as the space described inversely; hence the retarding force, which acts on the Cylinder mentioned in the data, is easily compared with gravity, supposing the resistance of the obstacle to be exerted solely on the impinging surface of this solid; which supposition is evidently true, when the effects of friction and of the condensation of the materials in the obstacle are taken equal nothing, which assumption is demanded by the conditions of the Problem, for without it the retarding force cannot be uniform.

In

In order to compare this force with gravity, it must be remembered, that if a body begin to ascend with an initial velocity $= n$, it will move through a space $= \frac{n^2}{4s}$; therefore, if the force of gravity be

denoted by the weight of the Cylinder, we have as $r : \frac{n^2}{4s} :: dqfg : \frac{dqfgn^2}{4rs} =$ the resistance opposed

to the motion of the solid mentioned in the data, which retarding force is $=$ the resistance of the obstacle exerted on the surface g — the weight of the solid, and therefore the whole resistance $= \frac{dqfgn^2}{4rs} + dqfg$. But if equal forces act on dif-

ferent surfaces, being uniformly applied to every point of each, the effects produced will be as the surfaces, consequently, as $g : e :: \frac{dqfgn^2}{4rs} +$

$dqfg : \frac{dqfen^2}{4rs} + dqfe =$ the resistance given

by the Obstacle to the Cylinder of the Problem. But the difference of this resistance, and the force arising from the sum of the weights of the Block and Cylinder, expresses the retarding force which constantly acts on the system that penetrates the

Obstacle, and is $= \frac{dqfen^2}{4rs} + dqfe - dqec - a$,

which quantity may be called h , and it may be here remarked that h is always affirmative, because

M m 2 . . . a negative

a negative retarding force, is an accelerating force acting in a contrary direction. Now the velocity of the Block before the instant of impact $= \sqrt{4sx}$, when x = the distance descended, through by the Block in free space, and the velocity of the system after impact $= \frac{a\sqrt{4sx}}{a+dqec}$: but if

$2s$ be the initial velocity, and gravity the retarding force, s will be the space described: from this and what has been said above this proportion will be

easily understood, as $\frac{4s^2}{a+dqec} : \frac{4sxa^2}{h \times a+dqec^2} :: s;$

$$\frac{a+dqec \times a^2x}{h \times a+dqec^2} = \frac{a^2x}{h \times a+dqec} = \text{the space}$$

penetrated by the system after the first stroke, which is therefore as x , that is, as the height descended by the block, and may be put $=tx$ by writing t for

$$\frac{a^2}{h \times a+dqec}. \text{ Then the height descended by}$$

the block before the second stroke $= x \times \overline{1+t}$.

Now in this process of penetrating the obstacle by repeated strokes, the quantity of matter, and the retarding force are given, consequently the spaces penetrated, will be as the squares of the initial velocities, that is, as the heights descended through by the block in free space; therefore, as $x:tx::$

$$x \times \overline{1+t} : tx \times \overline{1+t} = \text{the space penetrated after}$$

after the second stroke. And this quantity being added to $x \times \overline{1+t}$ gives $x \times \overline{1+t}^2$, for the distance of the required point from the top of the pillar after the second stroke. By proceeding in this manner we find the successive values of the heights descended through by the block before each succeeding stroke to be $= x, x \times \overline{1+t}, x \times \overline{1+t}^2, x \times \overline{1+t}^3$, continued to $x \times \overline{1+t}^{y-1}$, and those of the spaces penetrated by each stroke in succession, to be $= tx \times 1, tx \times \overline{1+t}, tx \times \overline{1+t}^2, tx \times \overline{1+t}^3$, continued to $tx \times \overline{1+t}^{y-1}$. Now it is evident that each rank of quantities exhibited above, constitutes a geometrical progression, but the sum of the latter, which is the sum of the spaces penetrated by all the strokes $= \frac{tx \times \overline{1+t}^y - tx}{t} = x \times \overline{1+t}^y - x = c$

per question, and $x = \frac{c}{\overline{1+t}^y - 1}$. Q. E. I.

COROLLARY I. When $y = 1$, $x = \frac{c}{\overline{1+t} - 1} = \frac{c}{t}$.

COR. II. Since $x = \frac{c}{\overline{1+t}^y - 1}$, $\overline{1+t}^y = \frac{c+x}{x}$, hence it appears that x cannot be assumed at pleasure, but must be, according to the conditions

ditions of the Problem, a quantity which will make the expression $\frac{c+x}{x}$, some power of $1+t$, whose index is y , a positive integer.

PROBLEM II. All things being supposed the same as in the last, it is required to determine the time necessary for completing the whole operation, on the supposition that the block rises from the top of the column before the first stroke, and that the velocity with which it ascends both then and afterwards is uniform, and equal to a given quantity b per second.

SOLUTION. The sum of the spaces described by the block in ascending $= x + x \times \frac{1+t}{1+t} + x \times \frac{1+t^2}{1+t} + \dots + x \times \frac{1+t^{y-1}}{1+t} = \frac{x}{t} \times \frac{1+t^y}{1+t} - x$; but

$x = \frac{c}{1+t-1}$ by PROB. I. therefore the sum $= \frac{c}{t}$.

Now as all these spaces are described by the ascending block with an uniform motion, we have as $b:1$

second $:: \frac{c}{t} : \frac{c}{bt} =$ the time spent in performing

this part of the business, which does not vary with y or x , but is made up wholly of constant quantities. From the laws of gravity we get the following expression for the time that passes while the block descends in free space, which is also a geometrical

metrical progression $\sqrt{\frac{x}{s}} \times : \sqrt{1} + \sqrt{1+t} + \sqrt{1+t^2} + \dots$ to $\sqrt{1+t}^{y-1} = \sqrt{\frac{x}{s}} \times \sqrt{1+t-1}^y$ When equal quantities of matter in

motion, are retarded by constant but unequal Forces, the times required to reduce them to a state of rest are as their initial velocities directly, and as their retarding forces inversely. Now in the present case we have the force of gravity = the weight of the system = $a + dqce$, and the velocity destroyed thereby in 1 second = $2s$; on the other hand, the resistance opposed by the obstacle to the given column, has been found = h , and the initial

velocity of the system after impact = $\frac{a \sqrt{4s}}{a + qdce}$ drawn

into the square roots of the spaces described by the block in its unimpeded descent; which spaces are

successively = $x \times 1, x \times \sqrt{1+t}, x \times \sqrt{1+t^2}$ continued to $x \times \sqrt{1+t}^{y-1}$. Hence as $\frac{2s}{a + qdce} : 1$

second :: $\frac{a \sqrt{4sx}}{h \times a + qdce} : \frac{a \sqrt{x}}{h \sqrt{s}}$ = the time spent

in penetrating the Obstacle after the first stroke: in the same manner it will be found, that the time required for the same purpose after each succeeding stroke

stroke $= \frac{a}{h\sqrt{s}}$ drawn into the square root of that

term of the progression last mentioned, which corresponds to the stroke, and the sum of these quantities

ties $\frac{a\sqrt{x}}{h\sqrt{s}} \times \frac{\sqrt{1+t-1}^y}{\sqrt{1+t-1}} =$ the whole time spent

in penetrating the Obstacle. Now the sum of the three parts of time found above $=$ the whole time

required for performing the operation $= \frac{c}{bt} +$

$\frac{\sqrt{x}}{\sqrt{s}} \times \frac{\sqrt{1+t-1}^y}{\sqrt{1+t-1}} + \frac{a\sqrt{x}}{h\sqrt{s}} \times \frac{\sqrt{1+t-1}^y}{\sqrt{1+t-1}} =$

$\frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \sqrt{x} \times \frac{\sqrt{1+t-1}^y}{\sqrt{1+t-1}} \dots \text{Q. E. I.}$

COR. I. Now, in this expression for the whole time, the quantities $\frac{c}{bt}$, $\frac{a+h}{h\sqrt{s}}$ and $\sqrt{1+t-1}$,

are constant, and have nothing to do with the variation of the time, the maximum and minimum of which depend on the variable part $\sqrt{x} \times$

$\sqrt{1+t-1}^y$; but $x = \frac{c}{1+t-1}$. therefore by squa-

ring, we have $x \times \sqrt{1+t-1}^2 = M =$

$\frac{c \times \sqrt{1+t-1}^2}{1+t-1} = \frac{\sqrt{1+t-1}^y \times c}{\sqrt{1+t-1}^y}$. Now, since

the

the ratio $\sqrt{\frac{y}{1+t-y}}$, and $\sqrt{\frac{y}{1+t+y}}$, constantly diminishes as y increases, it is plain the quotient of the former divided by the latter, or the last expression, is a minimum when y is such, that is when $y = 1$; on the contrary, the said expression will be a maximum when y is such, that is, when it is infinite.

But the time in general is $= \frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \sqrt{x} \times \frac{\sqrt{\frac{y}{1+t-y}}}{\sqrt{1+t-y}}$; but when $y = 1$, $x = \frac{c}{t}$

by PROB. I. COR. I. therefore the minimum of time $= \frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \sqrt{\frac{c}{t}}$. In order to find the time a

maximum, we have $\frac{y}{1+t} = \frac{c+x}{x}$ PROB. I. COR.

II. and $\sqrt{\frac{y}{1+t}} = \sqrt{\frac{c+x}{x}}$, $\sqrt{\frac{y}{1+t-y}} = \sqrt{\frac{c+x}{x}}$

$- 1$, $\sqrt{x} \times \sqrt{\frac{y}{1+t-y}} = \sqrt{c+x} - \sqrt{x}$.

Now suppose x infinitely little and y infinitely great, and we have $\sqrt{c} = \sqrt{x} \times \sqrt{\frac{y}{1+t-y}}$, which, being substituted for it in the general equation, gives

the maximum of time $= \frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \frac{\sqrt{c}}{\sqrt{1+t-y}}$,

which is therefore finite as well as the minimum.

COR. II. The Block has hitherto been supposed to rise, between every stroke, to that

N n

point,

point, to which it ascended before the first : But if, instead of this supposition, we now imagine it to rise after each stroke to the same height above the column, to which it ascended before, the following is the true method of calculating the time, wherein the Block will drive the whole column into the Obstacle, putting $x =$ the length of its ascent and descent in free space ; time of ascent $= \frac{x}{b}$; time of

descent in free space $= \sqrt{\frac{x}{s}}$; time spent in pene-

trating the Obstacle after the first stroke $= \frac{a}{h\sqrt{s}} \times$

\sqrt{x} . Now the sum of these three quantities $=$

$\frac{x}{b} + \frac{a+h}{h\sqrt{s}} \times \sqrt{x} =$ the time spent in making

one stroke ; but, as the time is the same after every stroke, putting y for the number of strokes, we have

$\frac{yx}{b} + \frac{a+h}{h\sqrt{s}} \times \frac{y\sqrt{x}}{1} =$ the whole time : Again,

the depth penetrated by each stroke $= tx$, by what has been found above ; and $txy=c$, per quest. Hence

$x = \frac{c}{ty}$ & $\sqrt{x} = \frac{\sqrt{c}}{\sqrt{ty}}$: writing these values

in the expression $\frac{yx}{b} + \frac{a+h}{h\sqrt{s}} \times \frac{y\sqrt{x}}{1}$, we have

$\frac{c}{bt} + \frac{a+h}{h\sqrt{s}} \times \frac{\sqrt{cy}}{t}$ for the whole time.

From

From this it is evident, without further consideration, that when y is a minimum, that is, when $y = 1$, the whole time of performing the process $= \frac{c}{b t} + \frac{a + h}{h \sqrt{s}} \times \frac{\sqrt{c}}{t}$ which is the same with the expression for the minimum found in the preceding Corollary, and the value of $x = \frac{c}{t}$ in both cases. But if x is supposed infinitely little, y will be infinitely great, and the time will be infinite also; it cannot, therefore, be compared with the minimum as in the former case.

SCHOLIUM. Though x may be taken infinitely little both in this and the preceding Cor. with the strictest propriety, yet it cannot be supposed to be *absolutely* equal nothing, without committing an error in mechanics. Because, while the Block descends through the least space imaginable, some motion will be generated, which will produce a proportionate impression on the Obstacle; but, if it actually rest on the top of the column, the system will only act on the plane that supports it by simple pressure; and, if its weight be less than the force required to overcome the cohesion of the particles which are to be removed, no change will take place. For want of attending to this circumstance, some who have attempted to solve the Problem contained in the last Corollary, find $x =$ nothing, when the time is a minimum. The foregoing conclusions

sions are true, when all the retarding forces are neglected in the calculation, excepting the resistance that is given by the Obstacle to the impinging surface, that is, to that end of the Cylinder which is perpendicular to the line in which the solid moves, and lies contiguous to the resisting matter. If the experiment were carefully made on an Obstacle consisting of homogeneous, yielding matter, the results of the calculation would perhaps be found to coincide pretty nearly with the results of the mechanical process; but if earth, sand, or other gross materials are to be penetrated, no such coincidence can take place.

In order to form a theory more consistent with matter of fact, it has been taken for granted, that the column is impeded in its descent after the stroke by a variable force, which increases in the direct ratio of the depth penetrated: But the conclusions that have been drawn from this hypothesis, are not mathematically true, because the calculation from which they are derived, is improperly conducted; for which reason, the following method is here subjoined, wherein mechanical principles are more strictly attended to.

PROBLEM III. If a Block whose weight $= o$, fall from a height $= a$, on a Cylinder whose weight $= m$, and which has already penetrated the Obstacle to a depth $= p$, it is required to determine the space penetrated by this stroke.

SOLUTION.

SOLUTION. Put $s = 16 \frac{1}{2}$ feet; $f =$ the variable resistance at the depth p ; $g =$ the constant resistance acting on the surface, perpendicular to the line in which the column moves; $x =$ the variable space penetrated: then the weight of the system $= o +$

$m = b$, its initial velocity $= \frac{o \sqrt{4 a s}}{b} = c$, then

the retarding force at the depth $p = g + f - b = h$:

and, by the hypothesis, as $p : f :: p + x : f + \frac{f x}{p} =$

the variable resistance at the depth $p + x$, to which

adding $g - b$, we have $h + \frac{f x}{p} =$ the retarding

force at the same point. Put $c - v =$ the velocity of the system, when $p + x =$ the depth penetrated;

then the fluxion of time $= \frac{\dot{x}}{c - v}$, and as 1 second :

$2 s :: \frac{\dot{x}}{c - v} : \frac{2 s \dot{x}}{c - v} =$ velocity destroyed by gravity

in the time $\frac{\dot{x}}{c - v}$; therefore as $b : h + \frac{f x}{p} :: \frac{2 s \dot{x}}{c - v} :$

\dot{v} ; hence $\frac{\dot{v}}{c - v} \times \dot{v} = \frac{2 s}{b} \times h \dot{x} + \frac{f x \dot{x}}{p}$; and

by taking the fluent $\frac{\dot{v}^2}{c - v} = \frac{2 s}{b} \times 2 h x + \frac{f x^2}{p}$,

But when $\frac{\dot{v}^2}{c - v} = c^2$, $x =$ nothing, and the fluent

corrected is $\frac{\dot{v}^3}{c - v} = c^2 \frac{2 s}{b} \times 2 h x + \frac{f x^2}{p}$; there-

fore

fore when $c-v =$ nothing, the system is reduced to

a state of rest, & $\frac{2s}{b} \times 2hx + \frac{fx^2}{p} = c^2 = \frac{4s o^2 a}{b^2}$;

which gives $x = \sqrt{\frac{2 o^2 p a f + b p^2 h^2}{b f^2}} - \frac{p h}{f}$. Q.

E I.

COR. I. If x and g be determined by experiment, f may be found; for by substituting, for h in the

equation, $\frac{fx^2}{p} + 2hx = \frac{bc^2}{2s} = \frac{2ao^2}{b}$, we get

$$f = \frac{2pa o^2 - 2bpgx + 2b^2px}{bx^2 + 2bpx}$$
; and, by two experiments, g may be determined; for let $A, P,$

X and F express the same quantities in the latter as a, p, x and f do in the former case: then $F =$

$$\frac{2PA o^2 - 2bPgX + 2b^2PX}{bX^2 + 2bPX}$$
; but, by hypothesis, as

$$p:P::f:F; \text{ therefore } \frac{2ao^2 - 2bgx + 2b^2x}{bx^2 + 2bpx} =$$

$$\frac{2Ao^2 - 2bgX + 2b^2X}{bX^2 + 2bPX}; \text{ and } g = \frac{X + 2P \times x + 2p}{2 \times x + 2p - X + P}$$

$$\times \frac{2Ao^2 + 2b^2X}{bX^2 + 2bPX} - \frac{2ao^2 + 2b^2x}{bx + 2bpx}.$$

COR. II. Hence the truth of the hypothesis, assumed in this Problem, may be established or refuted: for, if three experiments be made, two values of g may be determined from them; and, as g is supposed to be a constant quantity, these values will

be

be equal between themselves, provided the effects of the friction of the column, and the surrounding matter increase directly as the space penetrated: On the other hand, if the values of g thus found be unequal, it is evident, that the retarding force, occasioned by the cause last mentioned, varies in a ratio different from that assumed in the hypothesis. Should any one think of trying this experiment, in order to throw some light on the nature of the retarding force arising from this kind of impact, it will be proper to use a cylinder or right-angled parallelopiped, consisting of a hard polished substance, and containing some kind of heavy matter, such as lead, in order to fix the center of gravity of the whole, nearest the surface on which the impact is intended to be made. The instrument being thus prepared, should be dropt from different heights on a bed of sand, which has been previously moistened, to give it tenacity, and compressed by a force so applied as to make its density uniform, or nearly so. This manner of managing the experiment, not only simplifies the operation, but renders the expression for g less complex; for, since the weight of the falling block is the same with that of the system, o and b are equal; and as the impact is first made on the surface of the Obstacle, p and P vanish out of the equation: consequently $g = \frac{b + Abx}{Xx - X^2} - \frac{abX}{x^2 - xX}$. After all it is highly probable, that the variable part of the retarding force observes a ratio which is com-

pounded

pounded of the ratios of the depths penetrated, and of the square of the variable velocity; for, when one body slides along another, the friction which continually retards its progress, arises from the collision of the small, but unavoidable, protuberances of the two touching surfaces. Now it is evident from the Laws of Motion, that the retarding force occasioned by the concussion of two such protuberances, is directly as the velocity; the number of such concussions in a given time is in the same ratio; and the number of protuberances acting together is proportional to the touching surface of the sliding body: Consequently the effect of friction is in a ratio compounded of the touching surface and the square of the velocity; that is, in the present case, as the depth penetrated drawn into the said square.—From these considerations it is obvious, that the following Question must be resolved before a Theory can be obtained from calculation, which will bear any analogy to the result of experiment.

PROBLEM IV. Every thing remaining as in the last, excepting the variable part of the retarding force, which is now supposed to be as the depth penetrated drawn into the square of the velocity, it is required to determine the value of x , when $c-v$ vanishes.

SOLUTION. Let p , s , g , o , m and x represent the same quantities as in the last PROB. also put f = the resistance arising from friction at the depth p , with the initial velocity c ; then, since the friction

is as the square of the velocity and surface conjointly, we have, as $pc^2 : f :: \overline{p+x} \times \overline{c-v}^2 :$
 $\frac{pf + fx \times \overline{c-v}^2}{pc^2} =$ the variable part of the

retarding force; and the whole retarding force =
 $g - b + pf + fx \times \frac{\overline{c-v}^2}{pc^2}$, & $\dot{v} = \frac{2sh\dot{x}}{c-v.b}$

$\frac{2spf\dot{x} + 2sf^x\dot{x} \times \frac{c-v}{bpc^2}}$, putting $h = g - b$.

Let $\frac{2sh}{b} = r$, $\frac{2sf}{bpc^2} = t$, and by reduction we have

$r\dot{x} + t\dot{x} \times \overline{p+x} \times \overline{c-v}^2 = \overline{c-v} \cdot \dot{v}$

Now because x and v begin together, put $x =$
 $A v + B v^2 + D v^3 + E v^4 + K v^5 + \&c.$ where
the signs and values of A, B, D, E, K , &c. will be
determined by the resolution of a subsequent equation,
then $\dot{x} = \dot{v} \times : A + 2 B v + 3 D v^2 + 4 E v^3$
 $+ 5 K v^4 + \&c.$ and substituting for the values
of x and \dot{x} in the Equation $r\dot{x} + t\dot{x} \times \overline{p+x}$
 $\times \overline{c-v}^2 = \overline{c-v} \cdot \dot{v}$, we get $rA + tpc^2A +$

$\frac{2rB + 2tpc^2B + tc^2A^2 - 2tpcA \times v +$
 $3rD + 3tpc^2D + 3tc^2AB - 4tpcB - 2tcA^2 + tpA$
 $\times v^2 + 4rE + 4tpc^2E + 4tc^2AD + 2tc^2B^2 - 6tpcD$
 $- 6tcAB + 2tpB + tA^2 \times v^3 + 5rK + 5tpc^2$
 $K + 4tc^2AE + 5tc^2BD - 8tpcE - 8tcAD$
 $- 4tcB^2 + 3tpD + 3tAB \times v^4 = c - v.$ From

this expression, the values of the co-efficients $A, B,$

O o

$D, E, K.$

D, E, K , may be found by the common rule: for

$$r + t p c^2 \times A = c, \text{ and } A = \frac{c}{r + t p c^2} = \frac{c}{m}, \text{ and}$$

$$2 m B + t c^2 A^2 - 2 t p c A = -1, \text{ or } 2 m B =$$

$$2 t p c A - t c^2 A^2 - 1, \text{ and } B = \frac{2 t p c A - t c^2 A^2 - 1}{2 m}$$

$$= \frac{2 t p m c^2 - t c^4 - m^2}{2 m^3}; \text{ also } 3 m D + 3 t c^2 A B$$

$$- 4 t p c B - 2 t A^2 + t p A = 0, \text{ and } D =$$

$$\frac{8 t^2 p^2 m c^3 - 10 t^2 p c^5 - 4 t p m^2 c + 7 t m c^3 + 3 t^2 c^5}{6 m^4}$$

$$- \frac{2 t m^2 c}{6 m^4}. \text{ In the same manner may the values of}$$

E, K , &c. be found; therefore, putting $v = c, x =$
 $A c + B c^2 + D c^3 + E c^4 + K c^5 + \&c.$

SCHOLIUM. The difficulty of deriving any practical benefit in the present case from calculation, will appear from what has been done in the last Problem; for, after different values of x have been determined by experiment, and as many laborious calculations of the co-efficients of the successive powers of v in the Algebraic expression for the same quantity have been made, the values of f and g still remain to be ascertained by reversing the same series and others arising from it.

SKETCH of the HISTORY of SUGAR, in the early Times,
and through the Middle Ages. By W. FALCONER,
M.D. F.R.S. &c. &c. Communicated by DR.
PERCIVAL.

READ

THE use of Sugar is probably of high, though not remote antiquity, as no mention of it is made, as far as I can find, in the sacred Writings of the old Testament.* The Conquests of Alexander seem to have opened the discovery of it to the western parts of the world.

Nearchus,¹ his admiral, found the Sugar Cane in the East Indies, as appears from his account of
O o 2 it,

* Since writing the above, I have observed that the *sweet Cane* is mentioned in two places of Scripture, and in both as an article of merchandize. It does not seem to have been the produce of Judea, as it is spoken of as coming from a far country. *Isaiah*, chap. xliii. v. 24. *Jeremiah*, chap. vi. v. 20.—It is worthy of remark, that the word SACHAR signifies, in the Hebrew language, *inebriation*, which makes it probable, that the juice of the cane had been early used for making some fermented liquor.

¹ Ante Christ. Ann. 325;

it, quoted by Strabo.† It is not, however, clear, from what he says, that any art was used in bringing the juice of the cane to the consistence of sugar.

Theophrastus,¹ who lived not long after, seems to have had some knowledge of sugar, at least of the cane from which it is prepared. In enumerating the different kinds of honey, he mentions one that is found in reeds,‡ which must have been meant of some of those kinds which produce sugar.

Eratosthenes,² also, is quoted by Strabo,* as speaking of the roots of large reeds found in India, which were sweet to the taste both when raw and when boiled.

The next author, in point of time, that makes mention of sugar, is Varro,³ who, in a fragment

quoted

† Εἰρηκε δε περι των καλαμων οτι ποιησι μελι, μελισσων μη εστων. Straboni L. xv.

‡ Αλλη δε εν τοις καλαμοις. Fragment of Theophrastus preserved in Photius. See p. 864. Edit. Augsb. 1601.

* Και τας ριζας των φυτων, και μαλιζα των μεγαλων καλαμων, γλυκαιας και φυτα και εψησα. Straboni L. xv.

¹ A. C. 303. ² A. C. 223. ³ A. C. 68.

quoted by Isidorus, † evidently alludes to this substance. He describes it as a fluid, pressed out from reeds of a large size, which was sweeter than honey.

Dioscorides, ‡ † speaking of the different kinds of honey, says, that “there is a kind of it, in a “concrete state, called *Saccharon*, which is found “in reeds in India and Arabia Felix. This, he “adds, has the appearance of salt; and, like that, “is brittle when chewed. It is beneficial to the “bowels and stomach, if taken dissolved in water; “and is also useful in diseases of the bladder and “kidneys. Being sprinkled on the eye, it removes “those substances that obscure the sight.” The above is the first account I have seen of the medicinal virtues of sugar.

Galen² appears to have been well acquainted with sugar, which he describes, nearly as Dioscorides,

† Indica nam magna nimis arbore crescit harundo;
Illius e lentis premitur radicibus humor,
Dulcia cui nequeant succo contendere mella.

ISIDOR. lib. xvii. cap. 7.

‡ Est et aliud concreti mellis genus, quod *Saccharon* nominatur. In Indiâ vero et felici Arabiâ, in harundinibus invenitur. Salis modo coactum est; dentibus, ut sal, fragile; alvo idoneum et stomacho utile, si aqua dilutum bibatur; vexatæ vesicæ, renibusque auxiliatur. Illitum ea discutit, quæ tenebras oculorum pupillis offundunt.

Matthioli Diosc. Cap. lxxv.

¹ A. C. 35.

² Anno. Post. Christ. nat. 143.

rides had done, as a kind of honey, called *Sacchar*, that came from India and Arabia Felix, and con-
creted in reeds. He describes it as less sweet than
honey, but of similar qualities, as detergent,
desiccative, and digerent. He remarks a difference,
however, in that sugar is not like honey injurious
to the stomach, or productive of thirst.*

If the third book of Galen, "*Upon Medicines that
may be easily procured*," be genuine, we have reason
to think sugar could not be a scarce article, as it is
there repeatedly prescribed.

Lucan¹ alludes to sugar, in his third book, where
he speaks of the sweet juices expressed from reeds,
which were drank by the people of India.†

Seneca,² the philosopher, likewise speaks of an
oily sweet juice in reeds, which probably was
sugar.‡

Pliny³ was better acquainted with this substance,
which he calls by the name of *Saccaron*; and says,
that

* De simplic. Medicamentis. Lib. vii.

† Quique bibunt tenerâ dulces ab arundine succos.
LUCANI PHARSALIÆ. Lib. iii. lin. 237.

‡ Aiunt inveniri apud Indos mel, in Arundinum foliis,
quod aut ros illius cœli aut ipsius arundinis humor dulcis
et pinguior gignat.

SENEC. *Epistol.* L. I. *Epist.* lxxxiv.

¹ Lucani mors. A. D. 65. ² Senecæ mors. A. D. 65.

³ Plinii mors. A. D. 77.

that it was brought from Arabia and India, but the best from the latter country. He describes it as a kind of honey, obtained from reeds, of a white colour, resembling gum, and brittle when pressed by the teeth, and found in pieces of the size of a hazel nut. It was used in medicine only.†

Salmasius, in his *Plinianæ Exercitationes*, says, that Pliny relates, upon the authority of Juba the historian, that some reeds grew in the fortunate Islands which increased to the size of trees, and yielded a liquor that was sweet and agreeable to the palate. This plant he concludes to be the sugar cane; but I think the passage in Pliny ‡ scarcely implies so much. — Hitherto we have had no account of any artificial preparation of sugar, by boiling or otherwise; but there is a passage in Statius', that seems, if the reading be genuine, to allude to the boiling of sugar, and is thought to refer immediately thereto by Stephens in his *Thesaurus*.*

Arrian,

† Saccaron Arabia fert, sed laudatius India. Est autem mel in arundinibus collectum, gummium modo candidum, dentibus fragile, amplissimum nucis avellanæ magnitudine, ad medicinæ tantum usum.

PLIN. *Histor. Natural. l. xii. cap. viii.*

‡ PLIN. *Hist. Nat. lib. VI. cap. xxxii.*

* Et quas præcoquit Eboſita cannas
Largis gratuitum cadit rapinis.

STAT. *Sylv. I. vi. 15.*

Haud dubie (inquit Stephanus) cannas intelligit ex quibus

† A. D. circ. 80.

Arrian,¹ in his *Periplus* * of the Red Sea, speaks of the honey from reeds, called *Sacchar* (Σαχχαρ) as one of the articles of trade between Ariace and Barygaza, two places of the hither India, and some of the ports on the Red Sea.

Aelian,² in his natural History, speaks of a kind of honey, which was pressed from reeds, that grew among the *Prasii*, a people that lived near the Ganges.

Tertullian³ also speaks of sugar, in his book *De Iudicio Dei*, as a kind of honey procured from canes.†

Alexander Aphrodisæus ‡⁴ appears to have been acquainted with sugar, which was, in his time, regarded as an Indian production. He says; “that
“ what the Indians called sugar, was a concretion
“ of

quibus Saccharum exprimitur vel coquitur. Et fortasse Cannas pro Saccharo ipso posuit. Sed qui Ebofitæ illi, hætenus apud neminem invenimus. Populi fortasse sunt Indiæ, ubi saccharum potissimum nascitur. STEPH. *Thef. Vox Canna*. Lectio autem dubia est. Vide Not. MARKLANDI in hunc locum.

* Μελι το καλαμινον το λεγομενον Σαχχαρι. Page 150. Ed. Amstelod. 1683, 8vo.

† Mella viridanti confragant pinguia canna. TERTULLIAN. *de Iudicio Dei*.

‡ ALEX. APPRODISÆI, Lib. II. *Probl.* 79.

¹ A. D. 145.

² A. D. circ. 145.

³ A. D. 195.

⁴ A. D. 212.

“ of honey, in reeds, resembling grains of salt, of a
 “ white colour, and brittle, and possessing a detergent
 “ and purgative power like to honey; and which
 “ being boiled, in the same manner as honey, is
 “ rendered less purgative, without impairing its nu-
 “ tritive quality.”

Paulus Ægineta*¹ speaks of sugar, as growing, in his time, in Europe, and also as brought from Arabia Felix; the latter of which he seems to think less sweet than the sugar produced in Europe, and neither injurious to the stomach nor causing thirst, as the European sugar was apt to do.

Achmet, †² a writer, who, according to some, lived about the year 830, speaks familiarly of sugar as common in his time.

Avicenna, ‡³ the Arab physician, speaks of sugar as being a produce of reeds; but it appears he meant the sugar called Tabaxir or Tabbarzet, as he calls it by that name.

P p

It

* Paul. Æginetæ Vox Mel. Mel. P. 632. Medic. Art. princ. Ed. Henrici Stephani, 1567.

† Vide Meursii Gloss. Græc. Barb. & Du Cange Gloss. ad Script med. & inf. Græcitatibus.

‡ De Zuccaro. Lib. II. Tract II.
 De Melle. Lib. II. Tract II.

¹ A. D. circ. 400. vel secundum Friend multo posterior.
 Hist. Medic.

² A. D. 830. ³ A. D. 980. natus.

It does not appear, that any of the above mentioned writers knew of the method of preparing sugar, by boiling down the juice of the reeds to a consistence. It is also thought, the sugar they had was not procured from the sugar cane in use at present, but from another of a larger size, called *Tabarzet** by Avicenna, which is the *Arundo Arbor* of Caspar Bauhin, the *Saccar Mambu* of later writers, and the *Arundo Bambos* of Linnæus. This yields a sweet milky juice, and oftentimes a hard crystallized matter, exactly resembling sugar, both in taste and appearance.

The historians of the Crusades make the next mention of sugar of any that have fallen under my observation.

The author of the *Historia* †¹ *Hierosolymitana* says, that the Crusaders found in Syria certain reeds called *Cannameles*, of which it was reported a kind of wild honey was made; but does not say that he saw any so manufactured.

Albertus

* Some of the Writers say, that it was so called from the name of a place, *Σαχχαρ Ταβαρζης, τοπος εις καλσμενος εις Συριαν*. *Constantinus a Secretis*, MS. quoted from Du Cange Glos. Græc. The word *Tabarzet* signifies white, and is translated, by Du Cange, *Saccar Album*. Herbelot says, that the Persians called by that name the hardest and most refined sugar. *Bibliothèque Orientale*, p. 810.

† *Pars secunda*, p. 595.

Albertus Agnenfis * 1 relates, that about the fame period, “ the Crufaders found sweet honeyed reeds, “ in great quantity, in the meadows about Tripoli, “ in Syria, which reeds were called *Zucra*. Thefe “ the people (the Crufaders army) sucked, and “ were much pleafed with the sweet tafte of them, “ with which they could fcarcely be fatisfied. This “ plant (the author tells us) is cultivated with great “ labour of the husbandmen every year. At the “ time of harveft, they bruife it when ripe in “ mortars; and fet by the ftrained juice in veffels, “ till it is concreted in form of fnow, or of white falt. “ This, when fcraped, they mix with bread, or rub “ it with water, and take it as pottage; and it is to “ them more wholefome and pleafing than the honey “ of bees. The people who were engaged in the

P p 2

fieges

* Calamellos ibidem mellitos, per camporum planiciem abundanter repertos, quos vocant *Zucra*, fuxit populus illorum falubri fucco lætatus; et vix ad faturitatem præ dulcedine explere hoc guftato valebant. Hoc enim genus herbæ, fummo labore agricolarum, per fingulos excolitur annos. Deinde, tempore meffis, maturum mortariolis indigenæ contundunt, fuccum colatum in vafis fuis reponentes, quoufque coagulatus indurefcatur, fub fpecie nivis vel falis albi. Quem rafum cum pane mifcentes, aut cum aquâ terentes, pro pulmento fumunt; et fupra favum mellis guftantibus dulce ac falubre effe videtur. His ergo calamellis melliti faporis, populus in obfidione Albariæ Marræ et Archas multum horrendâ fame vexatus, eft refocillatus.

Gest. Dei per Francos, p. 279.

“ sieges of Albaria Marra and Archas, and suffered
 “ dreadful hunger, were much refreshed hereby.”

The same author, ¹ in the account of the reign of Baldwin, mentions eleven camels, laden with sugar, being taken by the Crusaders, * so that it must have been made in considerable quantity.

Jacobus de Vitriaco mentions, † ² that “ in
 “ Syria reeds grow that are full of honey, by which
 “ he understands a sweet juice, which by the pressure of a screw engine, and concretion by fire,
 “ becomes sugar.” This is the first account I have met with of the employment of heat or fire in the making of sugar.

About the same period, ‡ ³ Willermus Tyrensis speaks of sugar as made in the neighbourhood of Tyre, and sent from thence to the farthest parts of the world.

Marinus Sanutus mentions, § ⁴ that in the countries subject to the Sultan, sugar was produced in large quantity, and that it likewise was made in
 Cyprus,

* *Gesta Dei*, p. 353.

† *Sunt autem calamelli, calami pleni melle succo dulcissimo, ex quo quasi in torculari compresso, et ad ignem condensato, prius quasi mel posthæc quasi Zuccara efficitur.*

Gesta Dei, p. 1075.

‡ *Per institores ad ultimas orbis partes deportatur.*

Gesta Dei, p. 835.

§ *Marin. Sanut. L. I. Part. I. Cap. 2. — in parte secundâ Gesta Dei.*

Cyprus, Rhodes, Amorea, Marta, Sicily, and other places belonging to the Christians.

Hugo Falcandus, *¹ an author who wrote about the time of the Emperor Frederic Barbarossa, speaks of sugar being in his time produced in great quantity in Sicily. It appears to have been used in two states; one wherein the juice was boiled down to the consistence of honey, and another where it was boiled farther, so as to form a solid body of sugar.

The foregoing are all the passages that have occurred to my reading on this subject. They are but few and inconsiderable, but may save trouble to others, who are willing to make a deeper enquiry into the history of this substance.

Jan. 24, 1790.

* In præfatione ad Libr. de Calamitatibus Siciliæ.

† 1170.

The following Passage taken from the *Viridarium Francisci Mendozæ, Sacræ & Profanæ Eruditionis. Colonia Agrippinæ, 1633*, seems to point out, though rather obscurely, the construction and principles of Balloons.

“Vas ærcum, plenum aere, aliter demergendum, in summâ aquâ sustentatur, cum eâ sit naturaliter multo gravius; ergo navis lignea, aut cujuscunque alterius materie in summa aeris superficie constituta, *et elementari igne repleta*, supra aerem sustinebitur, nec prius in ipso aere submergetur, quam navigii gravitas superet levitatem ignis, quo plenum est.”

Problema XLVII. *Utrum aer parte aliquâ sit navigabilis.*

W. F.

Copy of a Letter from THOMAS BEDDOES, M. D. Physician, at Bristol Hot Wells, to Mr. THOMAS HENRY, F. R. S. &c.

READ, NOVEMBER 29, 1793.

Bristol Hot Wells, Oct. 17th. 1793.

DEAR SIR,

I BEG you to communicate, to the Gentlemen of your Society, a fact similar to those related by Mr. Willis.* At the bottom of one of Mr. Reynolds's smelting furnaces, at Ketley, there was found a green, glassy mass, which, after some exposure to the air, partly deliquesced; and, after a somewhat longer exposure, exhibited white efflorescences over its surface. These efflorescences I found to consist of carbonate of soda. Upon adding distilled water to some of the recent mass, and filtering it afterwards, I obtained a limpid solution, which, on the addition of vitriolic acid, yielded a blue precipitate, exactly, as far as I can judge from the description, of the same nature, at least of the same appearance, as some of Mr. Willis's precipitates. The filtered solution, probably, contained a triple salt, consisting of soda (mineral alkali) iron, and some third material. When the vitriolic acid detached the
alkali,

* Manchester Memoirs, vol. 4th, part 1st, page 87, &c.

alkali, the two other ingredients subsided on account of their insolubility. What this third material might be, I never investigated.

I am, dear Sir,

Your's with great regard,

THOMAS BEDDOES.

*Some OBSERVATIONS on the FLINTS of CHALK-BEDS,
in a Letter from THOMAS BEDDOES, M. D. Phy-
sician, at Bristol Hot Wells, to Mr. THOMAS
HENRY, F. R. S. &c.*

READ, NOVEMBER 29. 1793.

DEAR SIR,

DURING my residence at Oxford, I examined with great attention some chalk quarries, or pits, in that part of England, especially near Henley upon Thames. I hoped, or rather I wished to meet with appearances, indicating the manner in which the flints these beds contain have been formed and distributed. But I was totally unable to frame any hypothesis, such as would comprehend all the phenomena,

phænomena; nor could I acquiesce in any of the various explanations which mineralogical writers have offered. I inclose the few observations I made upon these curious bodies, and request that you will lay them before your Society.

I. It is well known that flints occur, for the most part, stratified. They seldom touch one another in the bed, but lie insulated, like the specimens in the drawer of a cabinet. In almost every stratum, I believe, nodules alternate with tables, or flat masses, varying in thickness and extent. I did, however, observe flints irregularly dispersed among the chalk. Suppose the floor of a room to be a flinty stratum, and the ceiling a sieve, through which chalk is falling; suppose, at the same time, that a by-stander tosses pebbles occasionally among the descending sand, and you will have an idea of the manner, in which these solitary masses are dispersed through the chalk.

II. The rough white crust, which surrounds each flint, and is at first sight so naturally mistaken for adhering chalk, is formed in consequence of the decay of the external coat of the flint itself. It perhaps is the immediate effect of the decomposition of the water that soaks through beds. That it is owing to the decay of the flint, evidently appears from the change that takes place on the fresh face of fragments, broken for the repair of the roads. These fragments, after a short exposure to the weather, become tarnished; by degrees they turn
milky

milky or opalescent, then white, opaque and rough superficially. We often find, that the surface of smooth bodies grows rough, when it is undergoing any chemical change, as in the familiar instance of polished iron rusting. The acquisition, or the loss of some constituent principle, produces a disarrangement of the superficial particles. By filling a phial with fragments of flint and water; and then inverting it in water, the cause of the change which the surface undergoes might be ascertained: Its progress at least would, in all probability, be observed.

III. Many nodules are hollow. These contain either a white powder, or a cellular spongy substance, which latter is more usually the case. A few are spherical, or nearly so; most are of an irregular roundish or flattened shape, with processes perforated by a hole, within which the contained porous matter appears, pointing outwards, and generally protruding as far as the orifice. A specimen in my possession might be thus exactly imitated. Take one of those oval phials, into which bent tubes are commonly inserted, for the purpose of obtaining elastic fluids by solution. Into this phial, put just acid and chalk enough to raise a foam that shall fill it; then conceive the foam to become concrete. In some specimens, I have observed the spongy mass to protrude beyond the orifice. And it seems to me obvious, from inspection, that the rarefied cellular substance, the powder, the

Q q

perforated

perforated processes, or *mamillæ*, and the holes through them, must have been really produced by the extrication of some elastic fluid. The few imperforated hollow nodules I have seen, are much more nearly globular than the others. In these, what is now the compact semi-transparent coat, must have yielded so much during the effervescence, as to afford space enough for the whole of the extricated elastic fluid. When the effervescence was rapid, or when the air was produced in large quantity, it burst its way out, producing an elongated mamillary process; and carrying along with it the effervescing substance within, as far as the orifice or beyond it. In the specimens containing powder, the effervescing matter must have become concrete, while its parts were disunited by the issuing air. Something of the same kind frequently happens to bars of cast iron, used as a grate for reverberatory furnaces. I have several times seen such bars, after having lain for weeks or months in the furnace, converted superficially into malleable iron, and within containing a grey powder. In two papers, printed in the *Philosophical Transactions*, I have shewn, that air is extricated during the conversion of cast into malleable iron. Now, in the bars which are found to contain powder, the application of heat occasions throughout the whole substance of the bar, an effort towards the extrication of air. But from some curious circumstances, described at length in the latter of the two papers above-mentioned, it appears, that the air
issues

issues from the iron with very little force, even when the heat is considerable. Hence it is extricated from the surface only of the bar; and this alone is converted into malleable iron. During this conversion, the surface is heaved and separated from the internal parts; and some space within is afforded for the extrication of air: And if the bar should be cooled while the particles are disunited, in consequence of this extrication, it will be found to contain a powder.

The dust and ashes, ejected in such abundance by volcanoes, must be produced by very nearly the same mechanism. Let us suppose a substance in fusion, from which, or from below which, air or steam is rapidly and copiously evolved—a very common occurrence at the time of an eruption. These elastic fluids issue with such prodigious violence as to dissipate the matter in fusion, and bear it forward, as dust is elevated by a strong wind. On its arrival in the atmosphere, or before, it is cooled, becomes concrete, and descends like snow upon the ground.

IV. The glassy texture and fracture of flints, in the first place, leads me to believe that they have been fused. I have sometimes, within the hollow specimens, seen filaments passing across from side to side—another analogy, as I apprehend the fact, with glass; these filaments having been drawn out in the manner of spun glass, as the flint bubble was blown up by elastic fluids formed within. In the same
light

light I consider the white opaque spots, so commonly appearing in the substance of flints.

Mr. Dolomieu (*Journal de Physique*, 1792) has related experiments, from which he concludes, that siliceous matter in a strong heat yields hydrogenic air. His experiments are not indeed perfectly decisive; because the air might have come from the alkali, with which he fused his siliceous earth. Should it however come from the flint, the fact would furnish an explanation of the appearances I have described. Streaks or weals may sometimes be observed upon the internal surface of hollow flints. I have seen these streaks round, and dilated at their termination. They must, I imagine, have been formed by viscid matter running upon the inside of the nodule. Exactly the same appearance might be produced, by letting flow down the inside of a tea-cup a liquid, too tenacious to run off the side entirely, but thin enough to reach the bottom, and form a small button there. If we could suppose, with Dr. Hutton, that flints were spouted into the body of the chalk from subterraneous fires, we might imagine the surface of each clot to have been cooled by coming into contact with the chalk, or during its passage, while the internal parts continued to boil and bubble, and work themselves into foam or powder. I cannot however conceive, how the nodules and tables could have been arranged, in the manner they are, by injection.

V. Balls

V. Balls of ochre are sometimes found in chalk-pits. These balls, on examination, clearly appear to have existed in some other state since their deposition in the chalk-beds. They contain lumps of matter, much resembling ferrugineous vitrifications: whence I conjecture, that the whole ball was once in the same state.

Long since this conjecture was formed, I observed in the quarries about Clifton, appearances which strongly confirm it. I have before me brecciated ferrugineous masses, and masses of friable ochre, each having precisely the same structure. I have even a series of specimens, from the hardest, reddish, brown ferrugineous breccia, to the most friable ochre, in which the angular fragments are seen perfectly; and, what seems to remove all doubt, you can perceive specks of ochre, beginning to form here and there in the hardest of these masses.—All the compact ferrugineous masses, which I have seen about Clifton, are varieties of *hæmatites*. I add, as a circumstance which seems to point out the origin of these masses, that a Gentleman one day last summer picked up in my presence, in a quarry between Gloucester Row and the Mall, a specimen of *hæmatites*, which has exactly the shape of a drop, falling from one contiguous surface to another. To that, which may be supposed the upper surface, it is attached by a narrow neck; while the body, a little flattened by
reason

reason of its size and specific gravity, rests upon the lower surface.

I am, dear Sir,

With great regard, your's,

THOMAS BEDDOES,

BRISTOL HOT WELLS,

NOV. 1, 1793.

EXPERIMENTS *and* OBSERVATIONS *on the* VEGETATION
of SEEDS. By MR. JOHN GOUGH.—Communicated
by DR. HOLME.

READ, FEBRUARY 21, 1794.

EVERY one, at all acquainted with natural history, knows that the seeds of many plants will, after lying in the ground for many years in a state of perfect inactivity, spring up, when the soil is broken, in full vigour, and with a profusion, that shews the earth to have contained them in great numbers. Reflecting on this curious phænomenon in July 1787, I made the following experiment, with a view to discover, what are the contingent circumstances, that give life and energy to the vegetative principle in the embryos of plants.

Experiment

EXPERIMENT I. Having nearly filled two phials with barley, that had been steeped in water for forty-eight hours; I corked one of them securely, and placed it in the dark. The other was buried at the same time in a box of light dry mould, its mouth being previously covered with a piece of thin cloth, to prevent sand and other impurities from falling into it. The contents of the latter bottle were found, at the end of three days, in a state of vigorous vegetation; every grain having one sprout, or more, of a considerable length. The grain in the phial which was corked retained its former appearance; but had contracted a smell that was disagreeable, and very different from that which it had when newly taken out of the water.

The only just conclusion from the preceding experiment, is, that a given quantity of soaked grain, either requires a given quantity of air to make it vegetate, or a free communication with the atmosphere at large. The philosophers of the last century knew, that the presence of air is necessary to the vegetation of seeds, because they remain unanimated *in vacuo*; but, if my memory do not deceive me, they were ignorant of the fact just now stated. I have, therefore, given it a place in this essay, partly because it appeared to be new; and partly because it occasioned the succeeding experiments, which are of a more decisive nature. But, before I enter on the detail, it may not be improper to say

say something on the structure, and the constituent principles of vegetables.

A plant is an organized body, consisting of fibres, vessels, and different organs, intended to produce different secretions by their specific modes of action : such are the gummy matter of the *Stigmata*, the *Pollen* of the *Antherae*, the honey of the *Nectarium*, and the different vegetable acids commonly contained in the *Pericarpium*.

The substances enumerated above, though very dissimilar in their sensible qualities, are made up of but a few primary elements, that are combined in various proportions in the respective compounds.

These are I. OXYGENE, or the basis of respirable gas. II. HYDROGENE, or the basis of inflammable gas. III. CARBONE, which when separated from the other two forms charcoal. Water, which is itself a compound, enters the absorbing vessels of all vegetables ; where it serves as a vehicle for the unassimilated particles, and afterwards escapes by perspiration, either wholly, or in part.

The foregoing matters are found in the composition of all vegetables ; and AZOTE, or the basis of mephitic gas, also, contributes to the materials discovered in the plants of the class TETRADYNAMIA. This substance unites, during putrefaction, with Hydrogene, and composes *volatile Alkali* : a property which is peculiar to the genera of the class in question. The parts of a seed are, the *Germ*, and the

seed

lobes. The former is a small bud, that appears to be the receptacle of the vegetative principle, where it lies torpid, till its activity is excited by foreign causes. The feed lobes are two soft bodies, which, cöhering closely, leave a notch between them for the reception of the Germ. They consist of a vegetable *oxyd*, or of a basis compounded of Carbone and Hydrogene, and impregnated with Oxygene: a quantity of oil, or of the basis not oxydated, is diffused through their substance. When seeds are covered with water, or buried in wet earth, they imbibe a portion of humidity; in consequence of which, the vegetative principle begins to exert itself, if not prevented by a want of a proper degree of warmth, or by other causes. It is highly probable, that no two kinds of seeds absorb equal quantities of water: For, I have found, that barley takes up only one-third of its weight of this fluid in forty-eight hours; but that peas charge themselves with three-quarters of their weight in the same time. Having stated the foregoing facts, which the nature of this essay seemed to demand, I shall proceed in the detail of my experiments.

EXPERIMENT II. One ounce of steeped barley being put into a bottle which would hold one ounce three drams of rain water; and also three drams of the same grain, prepared in the same manner, into a second bottle capable of containing four ounces of water; they were both closely corked, and placed

in a dark room, where the mean height of the thermometer was fifty-eight degrees during the experiment. At the end of four days, the three drams of barley, in the large bottle, had vegetated much; but the greater quantity, in the less bottle, had not produced one sprout. The same change in smell was however observed, which I have noted in the former cases. Hence it is evident, that a free communication with the atmosphere is not absolutely required, to bring the vegetative principle of seeds into action. On the other hand, it is equally manifest, both from this and the preceding experiment, that a given quantity of grain must be placed in a given quantity of air to make it vegetate.*

EXPERIMENT III. Since permanently elastic fluids escape very copiously from vegetables, subjected to the vinous and putrefactive fermentations, it might be supposed, that the same thing happens with seeds in the act of vegetating; and that this discharge being suppressed, for want of room, in the small bottle used in the last experiment, the expansion of the Germs was thereby prevented. In order to examine this matter with some care, I began with putting
several

* The second and succeeding experiments were repeated in the Autumn of this year (1793); when the present conclusions, founded on the new theory of chemistry, were also added.

several parcels of peas and barley, previously steeped, into small jars, and then covering them to different depths with water, both clean and foul. The seeds, thus treated, shewed no signs of vegetation, after specimens of the same kind, standing near them, in open bottles, had made a considerable progress. At the time, I attributed this inability to vegetate, to the air being excluded by the incumbent fluids; which supposition appeared more reasonable than the contrary opinion, namely, that some elastic matter was prevented from quitting the seeds, by columns of water not exceeding one inch in length, which can only press with a very slight force.*

EXPERIMENT IV. I put three drams of dry peas into a bell-glass filled with water; and inverted it in a small vessel of the same fluid. At the end of forty-eight hours the jar remained full, but a quantity of water, taken from the basin in which it stood, rendered lime water turbid; a proof that it contained Carbonic Acid. The same experiment was repeated with four drams of barley, and the result was nearly the same; only the presence of the Carbonic Acid was not so strongly indicated by the test of lime water.

EXPERIMENT V. Two ounces of water, in which barley had been soaked forty-eight hours, were put

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into

* Since this experiment was made, I find it not to be new. *Malpighi* did the same thing with the same result. *Vide Opera ejus*. Tom. I. p. 108.

into a pint bottle; an ounce-phial half filled with lime water, was suspended by a thread in the vessel, so as not to touch the liquor; the bottle was then closely stopp'd with a clean cork. The lime was precipitated from the water in the phial at the end of forty-eight hours. Hence we are authorized to infer, that Carbonic Acid Gas had been generated in the bottle during the course of the experiment.

EXPERIMENT VI. Being by this time convinced, that Carbonic Acid is produced by the vegetation of seeds; and believing with Mr. Lavoisier, that the acid in question consists of Carbone united to Oxygene, I endeavoured, in the next place, to discover whether the atmosphere or the vegetable oxyds of the materials used in my experiment, supplied the acidifying principle. For this purpose I placed seven drams twenty-three grains of steeped peas in a new phial, the mouth of which I covered with a piece of clean window glass, which was intended to condense the vapour, should any ascend into the neck. The bottle, thus prepared, was screened from the action of the light, so as not to prevent the free access of the air to its contents. At the end of one hundred and twenty hours, the peas were found to be vegetating freely, many of them having sprouts two inches long. The neck of the phial, and the glass that covered it, were free from moisture. The whole was then carefully weighed; and, the necessary deductions being made for the bottle and glass, the peas were neither more nor less than seven drams
twenty-

twenty-three grains, their original weight. The mean height of the thermometer, during the course of the experiment, was 59, 5°. I made the same trial, at another time, with a bottle containing one ounce three drams of steeped barley, and 6, 16 cubic inches of air. Besides using the same precautions observed in the last case, I frequently changed the air of the phial, by sucking it out through a slender glass syphon. At the end of ninety-six hours, the weight was decreased 2drs. 5 grs. The loss of this small quantity was probably occasioned by water escaping through the syphon, in combination with the Carbonic Acid Gas, and other permanently elastic fluids. Thus it appears, that the vegetation of seeds causes very little diminution of their weight, if any at all. On the contrary, the vinous fermentation of vegetable substances, is attended with a very sensible loss in this respect. Nevertheless the Carbonic Acid Gas is generated in both processes, and often so plentifully in the latter, as to burst the vessels containing the fermenting materials, provided a free egress be denied it; but no such force is observable in the former case. I therefore found it necessary to follow a different method, in order to discover the origin of this gas, during the first stage of vegetation.

EXPERIMENT VII. Six drams of steeped barley were put into a bell-glass, in the upper part of which it was secured by a muslin strainer stretched on a hoop of whalebone, tightly fitted to the inside

side of the bell. Seven ounce measures of atmospheric air were then introduced into the jar through the water in which it was inverted, care being taken that the height of the water within the glass should be on a level with that in the basin; which point was exactly marked on the outside. The barometer at the same time stood at 30, 25 inches; the thermometer at 54, 5°. In the space of eighteen hours the barometer had risen to 30, 31 inches, the thermometer being at 55, 5°; and the water inclosing the air appeared above the mark. Upon shaking the jar, the air contracted, which could only be occasioned by the absorption of Carbonic Acid Gas uniting with the agitated water: At the end of sixty-six hours, the grain had sprouted as much as could be expected in the time. It was judged necessary to put an end to the experiment, because the barometer and thermometer stood exactly at 30, 25 inches, and 54, 5°. The height of the water in the jar was carefully marked in the next place, and the contents of that part of the vessel, lying between this point and that fixed on at first, being accurately ascertained, it appeared that the air, in contact with the barley, had lost $\frac{1}{15}$ of its original bulk. The diminution would undoubtedly have been made still greater, by exposing it to lime water, but I did not pursue the subject any farther at that time, being contented for the present with determining the vegetative process to differ essentially from the vinous fermentation; for the Carbonic Acid

Acid Gas that escapes from fermenting substances, during the conversion of sugar into alcohol, is generated by those substances themselves. On the contrary, a part of the surrounding air is either absorbed by seeds in the act of vegetation, or a portion of its Oxygene is charged with Carbone derived from them. But this will be placed in a clearer light by the next experiment.

EXPERIMENT VIII. I put several parcels of steeped peas and barley, at different times, into phials, which were left to stand, for three or four minutes, in spring water, of the heat of $46, 5^{\circ}$, to reduce them to a known temperature. They were then securely corked, and removed into a room, the temperature of which was never less than 53° . After remaining from four to six days in this situation, they were again placed in the same spring water, and opened in an inverted position, care being taken that the barometer stood at the time nearly where it did at first. When a cork was thus drawn, a quantity of water rushed in immediately, more than was sufficient to fill the neck. The air being passed through lime water, contracted very sensibly, and precipitated the lime. The residuum, freed in this manner from Carbonic Acid, extinguished a lighted taper like water; and this it did repeatedly. I made one of these experiments with more attention than the rest, from which it appeared, that four ounces one dram forty grains, by measure, of atmospheric air, lost one-sixth of its original bulk, by
being

being confined five days, with one ounce of steeped barley. Now if the imperfections of my apparatus do not lead me into error, it is plain that seeds, in the act of vegetation, take Oxygene from the atmosphere, part of which they retain, and reject the rest charged with Carbone. The substances of the seed-lobes is hereby changed, an additional quantity of Oxygene being introduced into their composition; and a part of their Carbone lost. This change, in the proportion of their elementary principles, generates sugar, as is evident from the process of malting. But Sugar and Carbonic Acid are more soluble in water, than the farinaceous Oxyd. They therefore combine with the humidity in the capillary tubes of the seed, and find a ready passage to the Germ, the vegetative principle of which they call into action by a *stimulus* suited to its nature. A nutritious liquor being thus prepared, by the decomposition of the seed-lobes, and distributed through the infant plant, its organs begin to exert their specific actions, by decomposing the nourishment conveyed to them, and forming new Oxyds from the elementary principles of it, for the increase of the vessels and fibres; and in this manner the first stage of vegetation commences. One principal use of the seed lobes being ascertained, we are enabled to understand some experiments made by Malpighi. This industrious philosopher stripped the germs of a great number of beans, and a variety of other seeds, of their external coverings, and placed

placed them naked in the ground. Of all that he treated in this manner, only three beans vegetated, not in the usual way, but very imperfectly: vide *Malpighii opera* Tom. I. p. 109. It is evident then from the experiment of the Italian philosopher, that the juices of the earth, though fit for the nutrition of maturer plants, are insufficient to awake the latent energy of their Germs. But if the seeds be planted in the earth unmutilated, these juices are imbibed by their seed lobes, and there receive the impregnation which is necessary for the vegetative process; the atmospheric air, that contributes so much to the change in their composition, having free access to the seeds through the pores of the soil, as may be safely inferred from the first experiment. It is highly probable, that the Germs of the beans which attempted to vegetate, were not perfectly freed from the farinaceous matter; they therefore sprouted, but withered soon after for want of proper nourishment.

EXPERIMENT IX. Having now discovered the use of Oxygene to plants, in the first stages of their growth; I inquired, in the next place, what would be the consequence of inclosing seeds in azote, after saturating them with water. For this purpose, I put two equal quantities of steeped barley, viz. one ounce, one dram, thirty grains, into separate bell-glasses, where they were supported by strainers, as as in the seventh experiment. One bell was then set, with its mouth downwards, on a table, a small

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bottle

bottle of lime-water being placed under it. After filling the other with rain-water, and inverting it in a vessel of the same, I introduced into it seven and one-fourth ounce-measures of air, that had been confined more than a week with putrid flesh, in a vessel standing in water. The Barometer was at the time at 29,81 inches; a Thermometer, placed beside the jars, stood at 56°. The lime-water, in the bottle under the first glass, became turbid in the space of twenty-four hours. At the end of three days, the barley it contained had sprouted considerably, while the parcel in the other jar remained unaltered; nor was the bulk of the Azote confined with it increased or diminished perceptibly. The Barometer and Thermometer standing very nearly at the points specified above, when the bell glass was agitated in water, the inclosed air did not contract in the least: a proof that no carbonic acid gas was mixed with it. The jar being taken out of the water, and cleared of the gas, was placed on the table, with a bottle half-full of lime water under it. In fourteen hours, part of the lime-water was precipitated; and, in seventy-two hours, the grain had sprouted, just as if it had never been exposed to any thing but atmospheric air. I repeated this experiment, at another time, with four drams of steeped barley, and two and a half ounce-measures of air, being part of the residuum of a quantity of common air that had been in contact with a solution of liver of sulphur for eight days. The experiment was continued.

tinued six days without shewing the least sign of vegetation; but, on admitting common air into the glass, its contents sprouted freely. This experiment proves decisively, that seeds saturated with moisture have no affinity to Azotic Gas. It also appears, that the first stage of vegetation is analogous to combustion and respiration, all the three processes depending on oxydation by the atmosphere. I shall close this subject with the following remarks :

I. The only inference in this paper which seems to me doubtful, is, that seeds impregnated with water retain a part of the oxygene they absorb. To determine the matter with more certainty than I have done, the sixth experiment should be repeated over mercury.

II. It is probable, that some Hydrogene escapes from vegetating seeds, combined with Carbone; because the vessels used in the foregoing experiments retained a peculiar smell, even after being washed in clean water, but the action of the air destroyed it in a few hours.

III. I have found, that steeped grain confined, for four or five days, in small quantities of common air, will sometimes vegetate, and not in other cases. This, perhaps, is owing to variations in the general temperature; for when the Thermometer stands higher than 56° , it is probable, that the putrefactive fermentation commences sooner than when it is below that point. Lastly, the use, and even the necessity of having the soil very well

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pulverized,

pulverized, for the reception of a crop of grain or pulse, is explained by the preceding facts and observations: For when the turf of a field is reduced to a fine powder, the air finds free access to every part of it; and the seeds it contains, being placed in a temperature that is nearly uniform, and supplied with a necessary portion of humidity from the moist ground, are exposed in the most favourable manner, to the united effects of those causes, which are intended by nature to promote the growth and prosperity of the infant plant.

On *PLICA POLONICA*. By MR. FREDERIC HOFFMAN,
Surgeon to the Prussian Army.—Communicated by DR.
FERRIAR.

READ, MARCH 22, 1793.

SYNONYMS. *Lues Pocusiensis*: * *Trica*: *Trichoma*. POL.
Koldun or *Gozdz*. GERMAN. *Juden-zopff*: *wichtel-zopff*:
wixel-zorff: *weichel-zorff*.

DISEASES, the tendency of which is fatal, and the occurrence frequent, peculiarly claim the attention of the practical physician; while morbid affections which appear more rarely, and present unusual phænomena, more especially attract the enquiries of those

* *Pokusia* is a territory of Poland.

those whose object is the extension of general science. The disease termed *Plica Polonica* is of the latter class. It is endemic in Poland; and seldom, if ever, observed in any other part of Europe. During a long stay at Breslau in Silesia, I had frequent opportunities of observing this disease: and, as it is at present little known in Britain, I trust a brief narration of the principal circumstances connected with it will not prove uninteresting.

Both sexes are equally liable to the attacks of *Plica*. It usually appears during infancy; and but seldom after the age of twenty. When once produced, it continues during the remainder of life. The accession of the complaint is in general preceded by irregular spasmodic affections, pains in different parts of the body, a slow fever, and various diseases of the eyes; all which cease immediately on the appearance of the *Plica*.

The disorder consists in a præternaturally rapid growth of the hair, with a copious secretion of a viscid matter from its bulbs. For the most part, the hairs of the head are alone affected; and that only in peculiar parts. In these, the hairs grow considerably longer than in the rest; and are knotted and entangled with each other; being also covered with the viscid matter which issues from their roots, and which assists in gluing them together.

In proportion as the quantity of this gluten, and the implication of the hair increases, it is still more and more difficult to clean and comb it; hence
a degree

a degree of Phthiriasis is produced, and the head contracts an extremely foetid smell, to which however the Polish Peasants are so much accustomed that they endure it without complaint, or any manifest inconvenience.

It is also an opinion universally prevalent with them, that the disease is a salutary effort of nature to expel a morbid matter from the body; and that to interrupt the course of it would be productive of imminent danger; hence they make no attempt to cure, or even palliate the complaint. And if we may repose confidence in Authors of established reputation, morbid affections of a similar nature to those which precede its occurrence, paralysis, and even death itself, have succeeded imprudent attempts to check the progress of the disease. In this respect, Plica bears some analogy to the *exanthemata*, and various chronic cutaneous eruptions.

I am as yet unable to decide whether this complaint is hereditary or not. From some observations indeed it appears, that a predisposition to it may be transmitted from parents to their offspring; but my information on this head is too limited to ascertain the point. In one case which fell under my own observation, two brothers had Plica, both on the left side of the head, and in about one third of their hairs: I learned from them, that their father and grandfather had also been affected with the disease in a form exactly similar.

Besides

Besides the human species, other animals are subject to this complaint. It appears in some of the finest horses in Poland. In them it is situated in the mane, and sometimes in the long hairs around the hoof and fetlock joint. It attacks also the different species of the canine genus; dogs, wolves, and foxes. Previous to its occurrence in the first, the symptoms of *rabies* usually appear: the tail is dropped between the hind legs, there is a flow of frothy saliva from the mouth, the sight and appetite are impaired, or entirely lost; they are snappish, and disposed to bite, but their bite does not produce hydrophobia. The wolf is affected in the same manner; he leaves his wonted concealments in the woods, and runs wildly among the flocks, biting, and destroying them, but without producing hydrophobia.

The impossibility of ascertaining the true causes of this singular disease, has given rise to several vague conjectures on the subject; as that of Le Fontaine, who attributes it to a corruption of the fat.

It is somewhat remarkable, that *Plica* takes place only among the lower class of people; whence some have conceived, that it is to be considered merely as a consequence of uncleanness.

But, in objection to this opinion, it may be urged, that it is unknown in the adjoining countries subject to the Prussian Government, where the peasants are habituated to the same customs and mode

mode of life, or nearly the same as in Poland—that its appearance affords evident relief to the system, and its retrocession is productive of dangerous consequences. The idea that it is a real and idiopathic disease, is confirmed also by its occurrence in a variety of animals, and by the circumstance of its being confined to particular parts of the head; for which no reason can be assigned on the former supposition.

A peculiarity of climate cannot be adduced as a cause of this disease. Poland differs little in this respect from the adjoining countries. The summer heat is considerable, the thermometer rising frequently to 98°. 100°. 104°. and the cold in winter so great, that it falls sometimes 10, 15 degrees below 0. But though the changes in the atmosphere are so remarkable, at different periods of the year, they take place with the utmost regularity, the temperature passing, by insensible degrees, from one extreme to the other.

The Poles themselves are a vigorous, hardy race; inured from infancy to labour, and to exposure to the vicissitudes of the atmosphere; almost regardless of cold, they frequently sleep in the open air. Their diet consists chiefly of animal food, and they are much addicted to the use of spirits. They have an equal fondness for other strong stimulating liquids. I have seen them drink, with the greatest pleasure, the salt brine in which herrings have

have been preserved, and even nitrous acid diluted with water.

Since no other cause can be assigned for this disease, it is probable, that it arises, according to the general opinion, from contagion; a contagion which, like that of Pfora, can be communicated by contact only: but this I have not been able to ascertain by any observations of my own.

It is said, however, by authors of reputation, that Plica is frequent in Tartary; and that it was brought into Poland in the thirteenth century by the Tartars, who at that period made frequent irruptions into the eastern parts of Europe.

A perfect confidence in the liberality and candour of a Society, the exertions of which have added considerably to the treasures of science, encourages me to submit to it these few crude and cursory remarks; trusting that the most trivial contribution to the general stock, will not be deemed unworthy its attention. At some future period I hope to have opportunity and leisure to renew my observations upon the subject; and I shall endeavour to supply the deficiencies of the present Sketch, by transmitting to the Society the result of my future remarks.

On the COMBUSTION of DEAD BODIES, as formerly practised in Scotland. By Mr. ALEXANDER COPLAND.

READ, OCTOBER 4TH. 1793.

TO MR. HARVEY,

Secretary to the Manchester Literary and Philosophical Society.

SIR,

BEING informed that some Antiquarian Members of your Society were not altogether satisfied with the explanation given of the use of the Iron Instruments, described in the last half-volume of the Memoirs of the Literary and Philosophical Society of Manchester; I have stated some additional facts, and farther remarks on the subject, which I request you will present to the Society; and which I hope will be accepted of as a Sequel or Appendix to my former Paper.

I have the honour to be,

Your most obedient and obliged servant,

ALEX^R. COPLAND.

Dumfries, Sept. 30, 1793.

THE

THE following appear to be the principal arguments advanced in opposition to my opinions, concerning the use of the Instruments described and delineated in the last half-volume of the Society's Memoirs.

I. That the subject was of so very uncommon a nature, as hitherto to have escaped notice.

II. That the Instruments described might have been applied to other purposes, as husbandry, punishment, or torture.

III. That there appeared no necessity for the use of an iron apparatus in the process of consuming dead bodies.

IV. That the suspending of bodies for the purpose of combustion was indecent; and likely to cast some reproach on the memory of those, whose corpses had been thus treated.

In answer to the first objection I wish it to be observed, that although this subject has been much neglected hitherto by antiquarians,* yet the frequency of the objects in this country, and the

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numerous

* Mr. Pennant, in the first volume of his *Tour through Scotland*, is perhaps the first who describes Cairns as Sepulchres, for the Ashes of those, whose corpses had been consumed by fire.

numerous opportunities that have lately occurred to examine the contents of Cairns and other ancient Cœmeteries, have at last brought it into notice. In a statistical Account of the parishes of Rutherglen and Killbride, recently published at Glasgow, the author, Mr. David Ure, has confirmed every thing I have advanced respecting Cairns being true sepulchres; and added several interesting particulars of a similar nature.

He also (page 223) takes notice of a large Sepulchre, containing a number of urns, and a quantity of fragments of bones, situated in a place bearing a similar name to that where the instruments were found; and which appears to agree, in several respects, with the inclosure first described by me. It is called Strath-Blane: Strath means a portion of low and level ground, generally divided by a river;* and Blane seems to be the appellative or distinguishing name of this, from other Straths, being in all probability a Saxon word, (as none of the Highlanders I have spoken to seem to know its meaning) importing a place of sepulture. The farm at Caerlaverock, in which the cœmety is situated, is called Kell-blane: Kell (i. e. Cell)

* Thus, in Scotland, we have Strath-More, Strath-Spey, Strath-erne, Strath-Avon, &c. being long and level vales, with rivers of the names of More, Spey, Erne, &c. running through the midst of them.

Cell) intimating some place respected from pious or superstitious motives; or, as it may with seeming propriety be translated, the holy burying place, or *Cemetery*: For, in this country, the residences of holy persons or saints were called Kells or Cells, upon most of which churches are now built, and they are therefore at present generally called Kirks; and hence some proper names, which in former times began with Kell, are now changed to Kirk.* In consequence of the appellative Blane being joined in both instances to two substantives, that are generally conjoined with such distinguishing marks; and as there are *Cœmeteries* in both places, we are led to conclude, that the name in both has originated from this sole source.

Mr. Ure farther narrates, that a spade, resembling those found with the iron apparatus, was discovered lying with fragments of bones and urns under another Cairn.

We may certainly, therefore, be allowed to conclude from this similarity of names, and position of instruments,

* Thus we have in this country Kirkcudbright, *olim* Kell-Cuthbert, Kirkmichael, *olim* Kell-Michael, &c. with at least four parish churches of the name of Kirkpatrick, which were the cells or places where St. Patrick resided whilst on his Mission of Conversion, before he went to Ireland; and also the name of a family, now called Kirkpatrick, but which, in all old authors, is spelled Kellpatrick.

instruments, that they were used for the express purpose I have stated, and appertained to repositories of the dead. But what seems to confirm this position almost beyond a doubt, is the particular situation in which the iron instruments at Kell-Blane were discovered, being all included in one oblong niche, covered with common mould or earth. They consisted of a number of very strong and most curious chains; a pillared supporter; rings and blunt hooks highly ornamented; hoops of a different construction from those now in use; a pitchfork having its prongs squared, and therefore unfit for being used in husbandry, and also too large for culinary purposes; and a pair of large tongs.* These instruments, all of iron, with two spades or shovels, were deposited together in such a manner as plainly shewed, that they were intended to be used in concert, and only on very particular occasions. It was evident, that great care had been taken to conceal them, as will more fully appear from the following statement.

I was

* A pair of large tongs were also found along with the other instruments, but in so consumed a state, that they presently fell to pieces, and therefore could not be included in the number of those articles put into Mr. Riddel's possession. They were of the kind still in use amongst the common people here, having blades or sides above three feet long. Mr. Wilkins, the farmer of the ground, who was present when they were discovered, informed A. C. of this circumstance, soon after he had transmitted his paper, on this ancient Mode of Sepulture, to Dr. Percival.

I was lately informed by the farmer of Kell-Blane, or Kirkblane as it is more commonly though improperly called, that he had made some farther discoveries at the place where the articles of iron had been found, in consequence of my request, that he would be particularly attentive when cultivating that spot.

I went with him, accompanied by two of his servants, to a spot elevated about four feet above the ground around it, which, except in this part, slopes gradually to Locker Moss; and at the summit of this rising ground, I found a hearth, upon which wood had been burned at a distant period, there being a quantity of it charred lying on the surface of the till and stone pavement;* the grain of the wood was perfectly distinct, but the ashes, if such they could be called, though nearly of the usual colour, were changed to an earthy mould, much mixed with sand; this last was only found in the middle, and mostly in the interstices of the stones, as also below one or two of them.

The hearth appeared, on thorough examination, to be of an elliptical form, like a boat, the mouth of a spoon, or section of an egg-shell: being deepest in the middle, and covered over with good earth about two feet deep; becoming gradually shallower towards the edges, where it was one foot below the surface. Its dimensions were ten feet long by six broad
over

* The incorruptibility of charred wood is well known.

over the centre. It was paved with flat stones, that bore evident marks of scorching from fire, in the midst, and on the North-East and broadest end, where probably the head of the corpse had been suspended; but the other end was excavated out of the hard till, with a stratum of two or three inches of charcoal spread over it. The eminence was situated about fifty paces North-East of the middle of the large cœmetyery described in my paper; and about twenty-five paces South-East of the hearth was placed the niche, which contained the iron chains, &c. This last was cut out of the hard till, on the side of the rising ground, where no water could lie; and was covered with a rich mould. At the distance of fifty paces farther, on a low part of the ground, in the same direction, a rounded stone was observed, of a larger size than any in the neighbourhood, requiring the exertions of three men to turn it over. It was placed on a pavement of common round stones, to prevent its sinking.

This was evidently a land-mark, by which the niche, containing the iron apparatus, could always be discovered; though a circumstance by no means capable of attracting the notice of any, except those who came with the express purpose of finding it.

I would therefore ask any unprejudiced person, how he can possibly suppose, that this land-mark; the niche inclosing the extraordinary assemblage

blage of Instruments; and the elliptical Hearth, bearing evident marks of considerable usage; should be all so particularly situated in the same straight line, in the immediate vicinity of a large cœmety, and at the distance of two hundred and fifty yards only from a large cairn, (out of which the farm houses upon the ground have been built) except for the express purpose I have assigned to them, viz. for consuming the bodies of the dead, with as little expence of fuel as possible.

And surely nothing could accomplish this purpose so effectually as the concave form of the hearth. For this, when the comburator and other apparatus were used, by concentrating the heat around the body, would produce a much more complete combustion with less expence of fuel, than if the hearth had been upon a level.

From the situation also of this hearth, which is considerably under the height of that which appears to have been in the midst of the cemetery, it could not be seen, when used, from any part of the surrounding country, except from the other side of the moss, which is there three miles broad, and totally impassable.

All these circumstances seem fully to evince a strong desire of concealment, both during the ceremony and afterwards, arising probably from a favourite practice being partially continued, after it had fallen into general disuse; and perhaps after it

had been prohibited by law, and reprobated by the rest of the country.

II. With regard to the second objection, it is proper to state, that, from the remarkable aptitude which the various articles of the apparatus possess, for the different parts of the process of combustion, we are induced; or, in a manner, constrained to draw a similar conclusion. And indeed, on a thorough consideration, it will appear evident, that the experience of ages must have been necessary to produce all the different articles of the apparatus, in such perfection, and so particularly adapted to suspend every part and fragment of the body, till consumed, and reduced almost entirely to ashes; for no instance can be pointed out as superfluous, except the appearance of ornament on several of them may be so esteemed. It has been intimated that ostentation was here needless; but surely it was not more so in those superstitious times, at this awful and frequent ceremony, than the shew generally exhibited in the present age upon coffins, at funerals, and on monuments. However excusable ostentation may be in such circumstances, it is surely highly improper, as well as unnecessary, in every article of husbandry; and if such scrolls were to be added to the chains and hooks of carts, ploughs, &c. as were found on those connected with the rest of the apparatus, they

they would be rendered totally unfit for such purposes.

And, in like manner, the attempt to ornament instruments of torture or punishment, would have been equally improper, if not highly ridiculous. The iron hooks, also, that in such circumstances, without doubt, must have been struck into the flesh, for supporting the miserable victim, (as is still done in Russia) would have been sharpened; but these are broad at the points, and end in large knobs, so as to fit them only for supporting and retaining the hoops, &c. over a fire. And the number of hoops, of various sizes, and of such particular construction, along with the tongs, &c. clearly indicate their being intended for some process, where a heavy body was to be suspended over a strong fire. It may not be improper to remark, that the most useful watch-chain that has been invented, is of the same construction with those of the comburator; and I know of no other chain made in that manner.

III. With regard to the propriety and necessity of using an iron apparatus, permit me to observe, that notwithstanding all the accounts transmitted to us by the ancients, of consuming the dead by fire, describe the corpse as being laid on a high and extensive rogos, or pile; yet all these were honours paid to great men, for whom perhaps a whole country might be stripped of its wood,

But, with respect to the lower class in a populous nation, such a procedure would appear to be at least impracticable; and at this period, it is evident, that there is not so much wood growing, exclusive of gentlemen's plantations, as would construct rogi for the inhabitants who at present live in the country; so that there would be no wood left for husbandry, house-building, manufactures, &c. That this country was then very populous, and perhaps more so than at present, appears from the great number of these cairns in every part of it; several of which seem to have answered the purpose of large burying grounds, particularly one I saw, whilst dismantling, in which fragments of bones were equally dispersed through every different part—It was at least sixty feet in diameter, and the putrefaction was still going on so freely in it, in consequence of the internal parts being exposed to the air, that the workmen who came to it on a foggy morning, were so powerfully affected by the smell, as to become sick at stomach: it is situated within three hundred yards of the cemetery in which the iron triangle was found.

But farther, if ever wood became scarce, in a country where combustion of the dead was constantly practised, from being destroyed by war, accident, &c. the dead bodies must of necessity be consumed with coppice wood, small
branches

branches of trees, or shrubs of various kinds; the trunks of trees, if any existed, being retained for more urgent occasions. The body must have been laid on a pile of brush-wood; and, whenever the fire began to consume, it would, from the weight and moisture it contained, and for want of support for a sufficient length of time, fall to the bottom; and notwithstanding all the small wood that could be heaped on above it, would by no means be properly consumed, but only broiled. They must then have found the necessity of giving the body such support as was sufficient to keep it for a considerable length of time in the focus, or point of strongest action of the fire and flame. When they endeavoured to effect this by means of beams of wood, placed horizontally or perpendicularly, these would be speedily so far consumed as to permit the body in like manner to fall down, and be too low for the complete action of the fire; they must, therefore, at length have been reduced to the absolute necessity of having recourse to instruments of iron, or some other metal.

And, with respect to the opinion, that either peats, turf, or pit-coal, were ever used in this ceremony, I think we have sufficient reason to reject it; for all accounts of burning the dead, that are transmitted to us, agree in this, that nothing but wood was used on the occasion; and being at first solely appropriated to that purpose,

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no other fuel would probably be ever thought of. But at any rate it may be conjectured, that they would never use, for that purpose, fuel situated below the general level of the ground, whilst another could be procured, which, in its natural state, was considerably above its surface, and always endeavouring to ascend and approach nearer to the superior or heavenly regions; being in that respect typical of the expected ascent of the deceased, as a reward for his trials and sufferings in this life; whereas the use of the former would appear, to a superstitious people, ominous and adverse to the fond expectations of his friends. Besides, I believe there are no records of either peats or turf having been much, if at all, used by the Romans; and we are certain, that pit-coal did not come into use as fuel, till long after the period now treated of.

Thus after a full investigation of the subject, I think there is reason to be decidedly of opinion, that the ancients must generally (i. e. in cases of Plebeians) have had recourse to some such apparatus as is here alluded to, of iron, or other metal, for consuming the dead, notwithstanding all remembrance of it may have been lost, as well as of other matters of infinitely more importance to mankind.

Lastly: When we consider, that a number of brass and silver rings, and brass points of arrows and spears, evidently made by, or copied from the
Romans,

Romans; and that some Saxon coins have been also found in many of these Cairns;* and likewise, that the instruments of iron were in a state of high preservation, it would appear very improbable they could have been used above eight or nine hundred years ago; a period at which the Saxons governed in this country, who might have borrowed the custom of burning the dead from the Romans.† If these had been instruments of torture

* Several of these different articles were found in Cairns, in the parish of Crossmichael, and a specimen of each were presented some years ago, by William Copland, Esq. of Colliestone, my brother, to the Antiquarian Society of Edinburgh, with a view to their preservation. Repeated instances occur in Sir John Sinclair's Statistical Account, under the head of Antiquities, of circumstances corroborative of my opinions, particularly in the account of the parish of Leslie, volume VI. page 52. A Hearth, exactly such as that first described by me, was discovered in the the bottom of a Cairn, with a quantity of burnt bones, rings, and points of spears lying upon it.

† This agrees entirely with what we find in the Poems of Ossian. The graves of his heroes were known by a few large stones set upright, and no notice is taken of the Funeral Pile, or of the Tumulus or Cairn, which must have been introduced posterior to the period in which these Poems were composed. Some such stones are still known to remain. A description of the Sepulchre of King Galdus, or Galgacus, was sent by Robert Riddel, Esq. of Glenriddel, to the Antiquarian Society of London, and will probably soon be published. It is entirely of this kind; for he lived at the commencement of this period.

torture, the punishments must have been very cruel in those days; but we have always understood that our ancestors, the Saxons, were very lenient in their punishment of criminals; death seldom being awarded, and indeed most criminals getting off with fines of greater or less extent. Moreover, from these instruments being found in two parts of this country, at only fourteen miles distance, it would indicate, that enormous crimes, and their equally dreadful punishments, had been infinitely more frequent than at present, or than ever was heard of in any other country.

And also from spades having been found along with the iron apparatus, it is clearly indicated, that whatever had been subjected to the use of these instruments was intended to be inhumed; which certainly would never have been practised with criminals, or prisoners of war, whose corpses were generally left to glut the fowls of heaven, and beasts of prey.

I think at any rate it will be granted, that in consequence of the scarcity of wood, as already explained, numbers of the common people must of necessity have been exposed on such small and low Rogi, as would place the corpses opposite to, or under the eye of the attendants; and consequently in a more *indecent* posture, than when suspended in an iron triangle with the brush-wood placed under, over, and every way around them; and it may be

be proper to remark, that in this manner and position *alone* could the corpse be conveniently and completely consumed.

The custom of hanging criminals in chains in *Terrorem*, is, I believe, a modern invention; and, therefore, the idea of the use of these instruments being connected with disgrace and punishment could, at so remote a period, have no place.

OBSERVATIONS *on the* ADVANTAGES of PLANTING
WASTE LANDS. By THOMAS RICHARDSON,
Esq.

READ, FEB. 7TH. 1794.

IT has frequently been matter of concern to me, in travelling through different parts of the kingdom, to observe the decrease of Timber Trees in almost every county, whilst many large tracts of land, very suitable to the growth of wood, remain in a wild uncultivated state, of no use to their owners, and indeed unfit for any other purpose than that of planting. Of this kind may be fairly estimated one eighth part of the kingdom. Why these lands should remain in

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this unprofitable, comfortless, and disgraceful state to the owners, when they might be so easily converted into scenes of picturesque beauty, and yield so much benefit to the proprietors, is a circumstance I have frequently been at a loss to account for. To the enquiries I have made on this subject, the most general answer has been, "that wood would not grow on such land." But, I am led to conjecture the true cause to be, that the expence is *immediate*, and the profit at a *distance*. This doubtless has appeared, at the first view, to many a sufficient bar to improvements of this kind, yet I trust a fair and candid enquiry into facts, with the observations I shall adduce, on different plantations within my own knowledge, will sufficiently demonstrate, that a man may, within the compass of his own life, (if he begin to plant early) reap the reward of his labour, and also enjoy the pleasing reflection of the advantages he is preparing for his children by this rational and amusing employment, as well as the benefit and agreeable scenery the country will receive from so laudable an undertaking.

There are three kinds of land generally deemed unfavorable for the purposes of cultivation; and experience has proved, in most instances, that although more pains, labour, and expence have been bestowed in endeavouring to cultivate and
improve

improve such lands, than they could possibly have repaid if the attempt had been successful, the attempt was fruitless, and the money thrown away; whilst, with a fourth part of the expence in planting, the advantages would have been certain, and the profits have taken place at an earlier period, and in a much greater degree than could have been hoped for by any method of cultivation.

These three kinds of land are included under the following heads:

I. **BOGGY WET LANDS**, which, from their situation and nature, cannot be drained without an expence far beyond any probable advantages to be derived from their cultivation.

II. **STERILE HUNGRY LANDS.**

III. **BARREN ROCKY HILLS.**

Any person who has attentively viewed this country must have perceived, that lands of this description form fully as great a portion of the whole land of the kingdom as I have estimated. To this may be added, that there are few estates where there are not several parts, either from situation or aspect, of small value for grazing, or the plough; which, by planting, might be turned to much advantage by affording warmth and shelter to the cattle; keeping the bleak winds from the land; and supplying the farms with store of wood for fuel, fencing, and all the

various uses for which it is perpetually demanded: And the eventual profit would be certain, from the growth of excellent timber trees, selected from the choicest and most valuable part of the plantation.

I shall confine myself, in the observations I have to offer, to the three kinds of land specified, which, being generally deemed barren, are not of the annual value of sixpence an acre to the owners; and endeavour to prove the utility of applying such lands to the purposes I shall afterwards mention.

And, first, of the **WET LANDS**, and the trees best adapted for such places.

I shall begin with the **ALDER**, which thrives wonderfully in swampy ground; and there are few trees of greater general utility: But it is more particularly valuable in this neighbourhood (Manchester) where its uses are so various as to adapt it to an almost endless variety of purposes. The *wood* of this tree is in great esteem and demand for machinery; the cogs for mill wheels formed of it being proved, by experience, to be superior to any other. It is commonly used for bobbins; and the country people wear shoes, or, as they are usually termed, clogs made of it. Its excellent quality of resisting injury from water is universally acknowledged; hence its great value for pump trees, pipes,

pipes, drains, conduits to reservoirs, piles under water, and all kinds of wood-work which is kept constantly wet. The pipes which are laid under the streets of most large towns, to convey the water, are generally of Alder; and indeed in all works of the same nature, where it can be procured in sufficient quantity, it is preferred to every other wood. But it is much to be lamented, that the valuable properties of its bark should be so little known, that in most instances it is buried with the tree. The black dyers of cotton stuffs know its value, and make much use of it; they purchase it at the rate of seven to eight-pence the stone, laid down at their dye-houses. It is not chopped, but sold as it is stripped from the tree, after it has become moderately dry; so that there is no expence in chopping and cleaning it, as is the case with oak bark. It might be used to great advantage as an excellent substitute for many woods used in dying, which we have from abroad, and on which we expend considerable sums.*

A friend

* “ The *Koreki*, a savage nation inhabiting the borders of Russia, use deer-skins and dog-skins for their cloathing, which they dye with alder bark reduced to a fine powder. But their seal-skins, on which they set a higher value, they dye in a nicer manner.

“ They first clean off the hair, which they do very
“ dextrously

A friend of mine had a small piece of marshy ground, the produce of which never made him a shilling for many years. He had some thoughts of draining, and endeavouring to improve it for meadow land (the situation being favorable); but on my recommendation he planted it with Alders. The extent of it was something less than an acre, and the whole expence of planting cost him no more than twenty shillings. The plants did not cost any thing. He had some land over-run with young feedlings; two men were employed, who drew them and planted the whole in one week. In five years he cut them over, taking down every third or fourth plant, and thinning them judiciously, to afford room for the most thriving trees to expand in. These poles produced

“ dextrously by means of sharp stones. They then sew up
 “ the skin into the form of a bag, turning the hairy side
 “ outward; in this bag they pour a strong decoction of
 “ alder-bark, leaving it in this situation for some days, after
 “ which they hang it upon a tree, and beat it with sticks,
 “ until the colour has penetrated quite through the skin,
 “ so as to tinge it equally throughout. They then rip open
 “ the bag; and, stretching out the skin, leave it in the air
 “ until it is quite dry, after which they rub it with their
 “ hands till it becomes soft, and fit for use. They also dye
 “ the hair of their seal-skins a fine bright red colour, with
 “ a decoction of red wortle berries, alder-bark, alum, and
 “ *lac luna*.”

duced him fifty shillings, and the loppings for fuel more than repaid the expence of cutting down. In six years more, they were grown so strong and large, that he was under the necessity of taking down half of the remainder: These were of course the weakest trees: They produced in bark and wood, 8l. 14s. The cordwood became now so considerable as to be worth infinitely more than the expence of falling and peeling, as many of the branches were fit for stakes for fencing, and other purposes. It is three years since the last falling; and the rest on a moderate calculation, lately made, have been estimated at 13l. exclusive of the young poles or shoots. Thus, in fourteen years from the planting a piece of swamp, rather less than an acre, which had never before been productive to the owner, there have been already received eleven pounds four shillings; and timber is now standing to the estimate of thirteen pounds more: in all 24l. 4s. or 1l. 14s. 7d. yearly. But these are not all the advantages resulting from this plantation; for the leaves fall in such abundance each year, that they have added a tolerable soil productive of a coarse grass; which, being cut with the sickle in summer, is used as fodder for the young cattle within the house, during the heat of the day. I ought to observe, that, in this estimate, no account is taken of the expence
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of that very necessary article to all plantations, Fencing, the ground having been already enclosed. But, on the other hand, it must be remarked, that I have stated the profits of the plantation to its extent of fourteen years only; that, from the progressive state of its improvement, and the increased value which growing wood annually acquires after a certain age, it cannot be doubted but, in the next seven years, it will equal at least the value of the preceding fourteen years; particularly when it is considered, that the shoots, from the former cuttings nine years ago, are now sprung up into poles which are very numerous; and much larger than the parent plants were when cut down: the second cuttings are also in a proportionate state of increase.

The WILLOW will also grow luxuriantly in marshy ground; and produce great and lasting profit.

There are many species of this genus, all admirably adapted to various purposes; but, on the whole, I would recommend to the planter the three following as entitled to a preference.

The WHITE WILLOW (*Salix alba*)

The SALLOW (*Salix caprea*)

And the OZIER (*Salix viminalis*).

These three are in the greatest esteem; and applicable to every use for which trees of this genus are commonly employed.

Of the WHITE WILLOW I recollect a small plantation being made on a swampy piece of ground, in the year 1761, which grew so admirably, that the fairest and best trees were cut down in 1786. One of these which I measured was, at five feet from the ground, six feet five inches; and, at the length of thirty-two feet, four feet seven inches in circumference. There remained standing about ninety of the smallest trees, which were then thought unfit for cutting, having been robbed of their growth by the shade of the others: I measured the best of these trees at the time the others were cut down, viz. in 1786; it was only three feet ten inches in circumference, at six feet from the ground. I again measured this tree in 1793, at the same height; and it was no more than four feet four inches.

I mention this circumstance, to shew the slow progress made by this tree in the last seven years, compared with its growth in the former twenty-five years, under the disadvantage of being choaked and crowded by its more luxuriant and lofty neighbours: a fact affording full proof of the quick attainment of these trees to perfection.

The wood, from its peculiar whiteness, is in high estimation; and bears a good price for butter-firkins, milk-pails, casks for liquors, boards for flooring, chests, boxes, and various kinds of husbandry.—It is also excel-

lent for the tilts and sides of waggons, being very light, and yet exceedingly tough and pliable.

The SALLOW is a very quick growing wood; and extremely useful where new inclosures are to be made, either for the improvement of land or raising plantations, as it makes good stakes for hurdles.

I cut down one of these trees * in the winter, five years ago, from the stool of which, in the following autumn, a numerous offspring had arisen, some of which had shot out to the amazing height of ten feet. In the spring of the present year, (1793) having occasion for some hurdles to protect a young hedge of hawthorn just planted, I cut down these shoots for stakes. They were something too slender, but answered the purpose tolerably well. No wood burns clearer, with a brighter flame, or for
a greater

* From the bark of this plant in its green state, in the year 1788, were made, at Mill-Bank, near Warrington, fifteen reams of strong paper. It appears from the testimony of Mr. Greaves, the maker, that the paper made from ropes is sold at eight shillings and sixpence the ream; but that paper made from the bark of the *Withen* may be sold, with equal profit, at five shillings and eightpence the ream: And that pasteboard for book-backs, made from ropes, is sold at twenty-five pounds per ton, long weight of one hundred and twenty pounds to the hundred; but pasteboard of the same thickness, made from withen-bark, may be sold at seventeen pounds per ton.

a greater length of time, than the Sallow. It is even preferable, in this respect to the Beech. It emits little smoke, and is extremely sweet and wholesome.

It is almost unnecessary to speak of the value of the OZIER; for whoever contemplates the consumption of this estimable twig, in the immensity of wicker and basket-work which is used, must be convinced of the importance of its cultivation. The ingenious Dr. Hunter says, that a plantation of Oziers will produce from five to six pounds the acre annually, provided such plantations be in the neighbourhood of the basket-maker, or by the side of some river, which may enable him to send his wares by water, at small expence, to a proper market. Yet surely, at these prices, there are not many places in the kingdom such as have been described, which may not be successfully cultivated, and yield a very handsome profit, exclusive of the expence of carriage, especially since the great extension of our canal navigation.

The POPLAR, being termed by many writers an aquatic, has been frequently planted in an improper situation. In lands constantly wet, it may live for a few years, but it never arrives to any perfection in them; for where its roots are perpetually wet and cold, early symptoms of decay soon appear. With the exception

of those now mentioned, this tree adapts itself to most situations. It will thrive most luxuriantly on boggy moor-land, after it has been drained, of which I have a striking proof—I had some land of this description, so wet, as to be totally impassable by man or beast—After it had been well drained in the winter of 1790, it was planted in the ensuing spring with poplars of the following kinds :

The White Poplar (*Populus alba*)—The Black Poplar (*Populus nigra*)—And the Aspen (*Populus tremula*) and a few of the Carolina or Balsam Poplar.—These trees, when planted, were generally from two feet to two feet three inches in height ; and an inch and a half in circumference at the thickest part. I measured several of them in July, 1793, and they were, on the average, seventeen feet and a half in height ; in girth, at the ground, twelve inches and one-third ; and at a foot from the ground, ten inches and one-fourth. I have heard of more extraordinary shoots in trees of the same kind ; but I never saw any the growth of which on the whole equalled these. I planted several thousands of them in different soils, aspects, and situations, but none have yet come near to those planted in this drained morass.—Those on the edges of the brooks, in good soil, have succeeded next to these ; then those on sandy soil, and dry heath
lands ;

lands; and lastly, those on the stiff clay lands, which, although they have made pretty good progress, are yet the worst of all. Having a few plants left after the drained part was planted, and having heard it frequently asserted, as well as seen it supported by many authors, that they would succeed in the wettest places, I put them into the adjacent ground, which had not been drained, for the purpose of experiment—They seemed to strike tolerably well in the first year; but in the summer of the next, they grew sickly and turned yellow—I ordered a drain to be cut around them in the winter of that year—This had the desired effect, for the following spring they regained their former healthy hue, but the leaves were considerably smaller than in the others, and the plants much less, both in height and thickness; a sure proof that they will not thrive, or indeed live long, where the situation is too wet. Of the kinds thus planted, in the same situations, the white and black poplar grew the best; and on every account I prefer them, particularly the former.—It is scarcely possible to enumerate the many excellencies of this tree. To its valuable quality of adapting itself to so many different soils and situations, may be added the ease with which it is propagated. If the side-shoots be taken from the parent tree, planted in the ground, and defended from the bite of cattle,

cattle; they will need no farther attention. I put a number of cuttings, about a foot in length, into some ground well trenched, in the spring; and, in the autumn of the same year, they were grown to the height of upwards of four feet, were well rooted, and remarkably fine plants. They are of such rapid growth, that I saw a fall of this timber, which grew in a hedge-row, and had been planted twenty-five years, fell, on an average, at twenty-one shillings each tree; and I was afterwards informed that this price was much beneath their real value. I planted some Poplars (what we term Lombardy Poplars), about twelve years ago, which are now three feet two inches in circumference at the thickest part, and upwards of forty feet high. This is a pleasant looking tree, and does well enough in an ornamental plantation; but the wood is of little or no value. Another considerable advantage in the white or black Poplar, is that a greater number of them will grow on the same space of land, than of any other tree: For it is requisite, that all the side branches be dressed off, every two or three years, nearly to the top of the tree. This gives so much freedom to the circulation of the air, and admits the sun so freely among them, that, on the same space of land, may be brought to perfection, a number double to that of any other tree—For this reason we see them
so

so frequently planted in hedge-rows, by the sides of meadows and corn fields, in Lancashire and Cheshire, the farmers holding an opinion, that from the loftiness of the trees, and from their being kept lopped as I have described, they do no damage by their shade to the herbage or grain beneath them. It must be admitted, that they will do less injury than trees whose numerous branches and thick foliage are impervious to the sun and air; but I cannot agree that they do none at all: And, notwithstanding the beautiful appearance which trees planted in this manner give to the face of a country, I must condemn the measure of planting timber trees of any kind in hedge-rows, as being highly injurious to the fences beneath their branches, and the lands within their shade.

The wood of this tree is applied to many purposes: It makes excellent boxes and packing-chests, in which the manufactures of this town are conveyed abroad. Indeed there are few uses to which it is not applicable. With many people it is in high repute for flooring-boards, on account of its quality of resisting fire; for it burns with difficulty, and seldom bursts into a flame: on this account it is certainly very valuable in buildings. I am of opinion that no wood can be better adapted for false keels, or planking the inside of ships than
this:

this; and, in the scarcity of oak timber, every thing which can be found as a substitute, or may tend to lessen its consumption, must be considered of importance to the country.

The loppings and underwood afford excellent posts, rails, hurdles, and fencing.

Young cattle delight to feed on the leaves and fresh shoots of this tree more than any other; and where there are large plantations of it, in dry scorching summers, when the pastures afford little grass, the leaves will be found an excellent relief to farmers who have large stock of young beasts. If gathered in summer and cured like hay, they supply a valuable substitute for that article in seasons of severity.

The leaves fall in autumn in great abundance, and when left on the ground, improve it so much, as to render barren moor land fertile in a few years; and to those who live at a distance from great towns, and find a difficulty in procuring manure, I know few things of equal value in the improvement of all soils, but especially the light, thin, poor ones—Mixed with earth, they form a useful compost, and with the addition of a little kelp and lime, a cheap and excellent manure, as I can assert with confidence derived from experience.

The BIRCH is also a tree which will grow well in the situation I have been describing; but,

as

as this tree also delights in a light sandy soil, and as we need not its additional evidence to prove the advantages of planting barren waste lands, while we have many superior to it in value and in beauty, I shall pass over it, and proceed to land of an opposite description to what has been now considered.

II. Several parts of this kingdom abound in dry burning sands, in barren heaths, and moors unfavourable to every purpose of cultivation. The advantages which may result from planting such lands, may, in some degree, be appretiated by the recital of a few circumstances which have fallen within my knowledge :

I shall begin with a small plantation of Scotch Firs (*Pinus sylvestris*), growing on a moor in the North Riding of Yorkshire. This plantation is on a high mound of grey sand, in extent not more than three-fourths of a statute acre, which was laid down for this purpose thirty years ago. Its utmost value could not be estimated at two shillings and sixpence an acre annually. But that the subject I treat of, and its advantages may not be over-rated; and that no one may be led into error, I will allow at the rate of five shillings an acre, and calculate the benefits arising from it; stating the expences of planting and fencing agreeably to what I have paid myself for the same kind of labour; and estimating the timber, according to the valuation of an experienced person,

who examined it carefully, and offered the prices he stated, for the trees as they stood.

The whole fence was thirty-four rods in extent, of seven yards to the rod.

		<i>s.</i>	<i>d.</i>				
Casting the bank per rod	-	1	0				
Quicks cost	-	0	3				
Posts and rails	-	1	3				
		<hr/>			<i>£.</i>	<i>s.</i>	
34 rods, at	-	2	6	is	4	5	
Planting 1200 Firs	{	cost per 100 raising	1s. 0 12 0	{	1	4	
		making holes and planting	1s. 0 12 0		0	0	
Thirty years rent of three-fourths of an acre, at 3s. 9d. per annum					5	12	
Incidental expences (such as cleaning the plantation the first	{			{	6	0	
four years; keeping up the fence; and putting in trees					0	0	
where any failed) I estimate at					0	0	
		<hr/>			17	1	
There were standing 980 large trees, which at a low valuation of 2s. 6d. each, is	{			{	122	10	
					0	0	
Net profit in thirty years					105	8	
					6	6	

Therefore, after estimating the land much beyond its value, and making a full allowance for the cost and expences, it appears, this small plot of ground produced 3l. 10s. annually.

Here is another proof then of the great benefit resulting from planting such grounds: I have taken the estimate of the quantity of trees first planted at 1200, to allow for some failing; but I have made no account whatever of the trees which were taken out as they grew up, to give room for the increase of others, which would doubtless have more than repaid the labour of weeding and cleaning the plantation for the first four years; and also abundantly supplied the fences, if any were broken down, before the quicks grew up sufficiently.

As

As I have stated my concern at the general decrease of timber trees in the kingdom, and the extent of land so admirably adapted for the purposes of planting now lying waste, it is but justice to mention, that there are spirited individuals, both in England and Scotland, who have raised noble plantations of trees, in a state of annual improvement, on land which before produced little or nothing, being of so poor a quality that an acre of it would scarcely afford maintenance to a single sheep: on such are now growing thousands of valuable trees, rapidly advancing to profitable timber.—Among the foremost of these, may be ranked the plantations of the Earl of Fife, in the counties of Aberdeen, Banff, and Moray in North Britain. This nobleman, in the space of thirty years, has planted seven thousand acres of bleak inhospitable moors, and covered with beautiful forests a large extent of country on which a single tree never grew before; and where it was a general opinion, that trees could not thrive from the poorness of the land, and its vicinity to the sea coast. Another spirited undertaking of the same kind in the North of England, at Butsfield on Lanchester Moor, in the county of Durham, has been executed by Mr. White of Retford, in Nottinghamshire.—Accounts of both these plantations, and their increase, are detailed in a letter from the owners, addressed

addressed to the Society in London, for the encouragement of Arts, Manufactures and Commerce, and inserted in Vols. V. and VI. of that Society's Transactions.

An acquaintance of mine who formerly resided near Buttsfield, before Mr. White began his plantation, told me, that no land ever exhibited a more forbidding appearance, and that it was a prevailing notion in the country that the sum expended for its improvement would be thrown away: an opinion, to which, at the time, he was much inclined to accede. On his return, however, after an absence of a few years, with equal pleasure and surprize, he beheld the spot which he had left a barren waste, covered with goodly trees, at once an honour and benefit to the spirited undertaker, and an ornament to the country.

Those who forbear to plant their heath or moor-lands, from a supposition that they are incapable of rearing trees, may take an example of the fallacy of that idea, from the thriving state of the plantation which the Duke of Bedford has raised on Woburn sands.—A few years ago, the ground was a barren waste of hungry, sterile, devouring sand, which scarcely yielded sustenance to a blade of grass—the last time I passed the place it was changed into a wood of healthy thriving firs. I mention this young and small plantation, because

because every one who has passed that road must be convinced, that no land could have a more unpromising appearance for the growth of wood than this had.

I trust it has been proved by the foregoing facts, that two of the most unpromising kinds of land, in which this kingdom abounds, and which have hitherto been deemed barren, may, by attention, be brought to be equally, if not more profitable, than lands of the best quality in the usual course of husbandry.

Among the observations made, I have only pointed out such trees as seem best adapted to each situation; but I wish it not to be inferred from this, that others of our best and most valuable timbers will not also grow on the same situations — The contrary is the fact. And it is necessary that a judicious mixture of oak, ash, elm, and many other woods should be made in forming a plantation. The kinds I have described as most desiring these situations, and being of quick growth, will become excellent nurseries to others; and, as they attain maturity, or grow too thick, may be removed to make room for the rest, and thus furnish a constant succession of profits from the first planting. I cannot here refrain from speaking greatly in favour of the Larch Fir, (*Pinus Larix*) both as a tree of great beauty, which will make prodigious advances in such land as I have last described,

described, and also as a wood of great value, and an excellent defence for other trees, forming in a short time a comfortable screen around those that are less hardy. I have planted large numbers of them round some plantations I have made; and nothing can exceed the beautiful appearance these lively skirts of green exhibit early in the spring.

III. The last kind of land I shall notice in these observations, are those mountainous tracts of barren rocky hills, which are met with in many parts of the country; and which at present are nearly useless. It is unnecessary to enlarge much upon this subject, where the facts lie so much within the range of common observation. View the large chain of hills, or rather rocks, which separate the vale of Cleveland from the moors in the North Riding of Yorkshire! These hills are clad with oaks from the foot to the summit. Between Thirsk and Stokesley, woods of this description afford a most charming and delightful appearance for miles together: where the land in general, a flinty rock sloping to the north, is incapable of cultivation, having little or no soil, except the scanty portion which the rains have washed into fissures and crevices. In these oaks have fixed their roots, and made such growth, that, on one of the hills, a survey of the timber
made

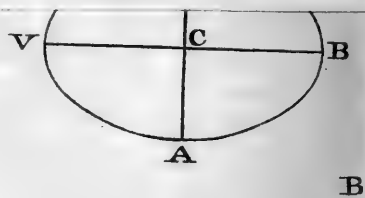
made about two years ago, as I am informed, estimated its value at thirty thousand pounds. What a noble fortune to the younger branches of the family to whom this wood was left!

Evelyn tells us, in his *Sylva*, of an Italian Nobleman, who, after his Lady was brought to bed of a daughter (considering that wood and timber were a revenue coming in whilst the owners were asleep) ordered his lands to be planted with 100,000 trees, calculating that each tree might be worth twenty-pence by the time his daughter became marriageable, which would amount to near 10,000*l.* which he intended to be her portion.

This practice I am told is not uncommon in Holland, where they plant the *ABELE* for the purpose of portioning out the younger branches of families; and this system must have our warmest approbation, if we consider the certain advantages resulting from it, and the benefit derived to a country from keeping up a succession of timber. Boucher reports, that he sold elms, of his own raising, at twenty-four years growth, for one guinea each, and these not selected, but a whole line of them together, consisting of above sixty in number: And he farther informs us, that he planted the eighth part of an acre of sterile red clay-land with ash trees, the product of which, in twenty-three years, was after the rate of £115 : 10 : 0. an acre,

or

or £5 per acre annually. But to detail proofs of advantages of this kind, established on unexceptionable authority, would require a volume. One circumstance, however, I cannot avoid mentioning. It is on the authority of Evelyn. He says, "It is supposed there may
" be twenty-six millions of square acres in
" the kingdom (exclusive of fens, highways,
" rivers, &c. &c. not estimated). Now,
" value but the annual growth of timber at
" four-pence each acre; and it will amount to
" nearly half a million sterling, exclusive of
" the mast and loppings." But if I estimate right, that, out of these twenty-six millions of acres, one eighth part is destitute of any profits whatever, and yet capable of being improved (as I trust has been shewn): allowing the annual growth of each acre to be no more than ten shillings on the average, the benefit to the country is upwards of one million five hundred thousand pounds each year, exclusive of the timber growing on the remaining twenty-three millions of acres. And, when we consider the large sums paid to foreign countries for timber, and its increasing scarcity in this, it will surely be worth the consideration of every true friend to his country, and every benevolent and patriotic mind, to reflect but a moment on the estimate thus moderately calculated. Let him then draw
the



the conclusion in his own mind, what profits will accrue to every judicious planter of timber, and what advantages our posterity and our country may reap from such exertions.

*The INVERSE METHOD of CENTRAL
FORCES.*

Communicated by EDWARD HOLME, M. D.

THE following Tract being upon a subject of considerable difficulty, the writer of it (whose name we are not permitted to mention) hopes it will be examined with due candour and lenity.

He is aware, that if it contain any thing new, it is in the third proposition. But, as it could not be easily detached from what precedes, this circumstance will he trusts be an apology for troubling the reader with *the whole* of what he has here done.

If proper *data* could have been procured, an attempt to calculate the motion of the Moon's *apsides* would have been made. But finding that a very small variation in the requisites already known affects the conclusions considerably, it was thought best to proceed no farther at present in so very complicated an enquiry.

THE INVERSE METHOD OF CENTRAL FORCES.

PROPOSITION I.

THE centripetal force being inversely as the n th. power of the distance from the centre, and the direction and velocity of a body at any point v being given; to determine the orbit, &c.—

Fig. I. Let C be the centre of force, V the point from which the body is projected, VnW the trajectory in which it moves, and VZ a circle described from the centre C at the distance CV : to the points V, n , of the orbit draw the tangents VP, np ; and from the centre of force C let fall the perpendiculars CP, Cp upon the tangents; join C, n , and produce Cn to Y , and draw CtX indefinitely near to Cny ; lastly, draw tv perpendicular to Cn . Put $CV=r$,
 $CP=$

$CP=P$, $Cn=y$, $Cp=p$, the velocity at $V=v$, the velocity at $n=u$, the velocities being measured by the spaces described in the time (1).

If O be the centre of curvature of the trajectory at the point n , then it is well known that $On = \frac{y\dot{y}}{\dot{p}}$. Draw OR perpendicular to Cn ; the triangles Cpn , ORn are similar, therefore $Cn(y) : Cp(p) :: On\left(\frac{y\dot{y}}{\dot{p}}\right) : Rn = \frac{p\dot{y}}{\dot{p}} = \frac{1}{2}$ chord of curvature passing through the centre of force. But the centripetal force, estimated by the velocity generated in the time (1), is = the square of the velocity divided by $\frac{1}{2}$ the chord of curvature $= u^2 \div \frac{p\dot{y}}{\dot{p}} = \frac{u^2 \dot{p}}{p\dot{y}}$; and $p^2 : P^2 :: v^2 : u^2$; therefore the centripetal force $= \frac{P^2 v^2 \dot{p}}{p^3 \dot{y}}$. Let

this expression be put $= \frac{A^{n+1}}{y^n}$, A being a constant quantity; wherefore $\frac{P^2 v^2 \dot{p}}{p^3 \dot{y}} = \frac{A^{n+1}}{y^n}$.

Multiply both sides of the equation by \dot{y} , and take the fluents, then $\frac{P^2 v^2}{2 p^2} = \frac{A^{n+1}}{n-1 \times y^{n-1}}$.

But at V this equation becomes $\frac{P^2 v^2}{2 P^2} =$

$\frac{A^{n+1}}{n-1 + r^{n-1}}$, therefore the correct fluent gives

$$\frac{P^2 v^2}{2 p^2} - \frac{v^2}{2} = \frac{A^{n+1}}{n-1 + r^{n-1}} \times \frac{r^{n-1} - y^{n-1}}{y^{n-1}}.$$

If a body descend directly towards the centre by an accelerating force $= \frac{A^{n+1}}{y^n}$, and $u =$ the velocity it has acquired when at the distance y from that centre, then it is well known that

$\frac{A^{n+1}}{y^n} \times -y = u \dot{u}$. Take the fluents; then

$\frac{A^{n+1}}{n-1} \times y^{n-1} = \frac{u^2}{2}$, or $\frac{2 A^{n+1}}{n-1} \times y^{n-1} = u^2$, which

requires no correction if the body descend from an infinite height; for in that case both sides of the equation vanish at the same time. At

the point V , therefore, or at the distance r from the centre, the square of the velocity acquired by descending from an infinite height $=$

$\frac{2 A^{n+1}}{n-1} \times r^{n-1}$. Let therefore in general $\frac{2 m A^{n+1}}{n-1} \times r^{n-1}$

$= v^2$, where m may be either greater, equal to, or less than unity. Hence by substitution and reduction, we have

$$\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}$$

$$1. p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}},$$

$$m > 1.$$

$$2. p = \frac{P}{\frac{r^{n-1}}{2}} \times y^{\frac{n-1}{2}},$$

$$m = 1.$$

$$\sqrt{\frac{m}{1-m}} \times P y^{\frac{n-1}{2}}$$

$$3. p = \frac{\sqrt{\frac{m}{1-m}} \times P y^{\frac{n-1}{2}}}{\sqrt{\frac{r^{n-1}}{1-m} - y^{n-1}}},$$

$$m < 1.$$

There-

Therefore it is evident, that if a body be acted upon by a single force which tends to a fixed point, the law of that force being given, the equation of the curve it describes has been determined: except in that particular case where $n=1$, or the force is inverfely as the distance of the body from the centre; for then the above equations fail.

Take $s:1::$ velocity in the curve at V (v):
velocity in a circle at the same distance $=\frac{v}{s}$,

then $\frac{v^2}{s^2} \div r = \frac{v^2}{s^2 r} = \text{force at } V = \frac{A^{n+1}}{r^n}$;

whence $v^2 = \frac{s^2 A^{n+1}}{r^{n-1}} = \frac{2 m \times A^{n+1}}{n-1 \times r^{n-1}}$, therefore

$s^2 = \frac{2 m}{n-1}$, and $m = s^2 \times \frac{n-1}{2}$; which value of m may be substituted for it in any of the three equations found above.

When $n=1$, we have $\frac{P^2 v^2 \dot{p}}{p^3} = \frac{A^2 \dot{y}}{y}$; hence,

by taking the fluents, $\frac{P^2 v^2}{2 p^2} = A^2 \times \log. \frac{1}{y}$; but

at V , this equation becomes $\frac{P^2 v^2}{2 P^2} = \frac{v^2}{2} = A^2 \times$

$\log. \frac{1}{r}$; therefore the fluent corrected gives

$\frac{P^2 v^2}{2 p^2} - \frac{v^2}{2} = A^2 \times \log. \frac{r}{y}$. But we have juft

found

found that $\frac{v^2}{s^2 r} = \left(\frac{A^{n+1}}{r^n} \right) \frac{A^2}{r}$ upon the pre-

sented supposition; therefore $A^2 = \frac{v^2}{s^2}$: substitute

and reduce, then $p^2 = \frac{P^2}{1 + \frac{2}{s^2} \times \log. \frac{r}{y}}$, or $p =$

$\frac{P}{\sqrt{1 + \frac{2}{s^2} \times \log. \frac{r}{y}}}$, the equation of the curve.

Next, to find the angle described, or the position of the line joining the centre of force and the body in respect of the line CV for any given value of it. By similar triangles we have $y^2 : p^2 :: tn^2 : tv^2$, and by division,

$$y^2 - p^2 : p^2 :: vn^2 : tv^2$$

also, $y^2 : r^2 :: tv^2 : XY^2$;

exæq. $y^2 - p^2 : y^2 : r^2 : p^2 :: vn^2 : XY^2 :: \dot{y}^2 : \dot{z}^2$ (\dot{z} being supposed $= XY$); consequently

$$\dot{z} = \frac{r p \dot{y}}{y \sqrt{y^2 - p^2}}, \text{ whatever be the}$$

value of n . Substitute therefore, in this equation, the several values of p found above, and there will arise the following equations:

$$1. \dot{z} = \pm \frac{r \sqrt{\frac{m}{m-1}} \times P y^{\frac{n-3}{2}} \dot{y}}{y \sqrt{y^{n-1} - \frac{m}{m-1} \times P^2 y^{n-2} + \frac{r^{n-1}}{m-1}}}, m > 1.$$

$$2. \dot{z} = \pm \frac{r P y^{\frac{n-3}{2}} \dot{y}}{\sqrt{r^{n-1} y^2 - P^2 y^{n-1}}} = \pm \frac{r y^{\frac{n-5}{2}} \dot{y}}{\sqrt{\frac{r^{n-1}}{P^2} - y^{n-3}}}, m = 1.$$

$$3. \dot{z} = \pm \frac{r \sqrt{\frac{m}{m-1}} \times P y^{\frac{n-3}{2}} \dot{y}}{y \sqrt{\frac{r^{n-1}}{1-m} - \frac{m}{1-m} \times P^2 y^{n-3} - y^{n-1}}}, m < 1.$$

If $n = 1$, then by substituting, in the same equation, the value of p found above, we have

$$\dot{z} = \pm \frac{r P \dot{y}}{y \sqrt{1 + \frac{2}{s^2} \times \log. \frac{r}{y} \times y^2 - P^2}}. \text{ Hence}$$

all the curves may be constructed.

It must be observed, that the positive or negative sign takes place, according as the body ascends from, or descends towards the centre.

$$\text{Because } p^2 = \frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}} \text{ in general, and}$$

at an apse it is evident, that $p = y$; hence, in that case, there arises by reduction, the following equation; viz. $y^{n-1} - \frac{m}{m-1} P^2 y^{n-3} + \frac{r^{n-1}}{m-1} = 0$; from whence, and the proper equation for \dot{z} , the number and position of the apsides may be determined.*

It may be observed that the quantity under the radical in the value of \dot{z} being put $= 0$, gives the equation for determining the apsides.

If m be supposed greater than unity, and y infinite, then will $p = \sqrt{\frac{m}{m-1}} \times P = a$ perpendicular upon the asymptote to the curve described

* See the note placed at the end of this Tract.

scribed by the body, or its distance from the centre of force. This expression, it may be observed, is not affected by the value of n . Hence if the value of z be determined upon the above supposition, the asymptotes to the trajectory may easily be drawn.

If m be less than unity, and y infinite, then

$$p = \frac{\sqrt{\frac{m}{1-m}} \times P}{\sqrt{-1}};$$
 therefore the curve has not an asymptote. Lastly, if $m = 1$, the perpendicular upon the asymptote will be infinite.

In all these cases the body may descend to the centre, if n be greater than unity; because in that case, when $y = 0$, $p = 0$. But if n be less than unity, the body can only arrive at the centre in a straight line. For the equation

$$p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}, \text{ becomes } p = \frac{\frac{1}{2} m P r^{\frac{1-n}{2}}}{\sqrt{\frac{m}{m-1} \times r^{1-n} + y^{1-n}}};$$

in which case, when $y = 0$, the value of p is positive, infinite, or impossible, unless P at the same time be equal to nothing. But it is evident that p can never be greater than y .

It will likewise easily appear, that when $n=1$, the body may descend to the centre; for

$$\text{for } p^2 = \frac{P^2}{1 + \frac{2}{s^2} \times \log. \frac{r}{y}} = P^2 \div \text{by an infinite}$$

quantity when $y = 0$.

But if the body begin to ascend, the greatest height at which it can arrive may be found, by making $p = y$; at which time it comes to an apse.

COR. 1. If $n = 0$, or the force be the same at all distances from the centre, then $p =$

$$\sqrt{\frac{m}{m-1} \times P y^{-\frac{1}{2}}} ; \text{ but } m = s^2 \times \frac{n-1}{2} = -\frac{s^2}{2}$$

$$\sqrt{y^{-1} + \frac{r^{-1}}{m-1}}$$

$$\text{therefore, by substitution, } p = \frac{s P r^{\frac{1}{2}}}{\sqrt{s^2 + r^2} \times r - 2 y}$$

the equation of the curve described by the body.

Likewise, it will easily appear, that $z =$

$$\frac{s P r^{\frac{3}{2}} y}{y \sqrt{-y^3 + \frac{s^2 + 2}{2} \times r y^2 - \frac{s^2}{2} \cdot P^2 r}}$$

The equation

for determining the apsides will be found to be

$$y^3 - \frac{s^2 + 2}{2} \times r y^2 + \frac{s^2}{2} \cdot P^2 r = 0. \text{ This equation}$$

has three real roots, as is evident from the latter part of the note in the proposition: two of them are positive and one negative; for the last term of the equation is positive. The nega-

tive root belongs to a part of the algebraical curve whose concavity is turned from the centre of force.

COR. 2. If $n=2$, or the force be reciprocally as the square of the distance, the value of p will become

$$1. \ p = \frac{\sqrt{\frac{m}{m-1}} \times P y}{\sqrt{y^2 + \frac{r}{m-1} y}}, \quad m > 1$$

$$2. \ p = \frac{P}{r^{\frac{1}{2}}} \times y^{\frac{1}{2}}, \quad m=1.$$

$$3. \ p = \frac{\sqrt{\frac{m}{1-m}} \times P y}{\sqrt{\frac{r}{1-m} y - y^2}}, \quad m < 1$$

And the respective values of z will be

$$1. \ z = + \frac{r \sqrt{\frac{m}{m-1}} \times P y}{y \sqrt{y^2 + \frac{r}{m-1} y - \frac{m}{m-1} P^2}}, \quad m > 1$$

$$2. \ z = + \frac{r P y}{y \sqrt{r y - P^2}}, \quad m=1.$$

$$3. \ z = + \frac{r \sqrt{\frac{m}{1-m}} \times P y}{y \sqrt{-\frac{m}{1-m} P^2 + \frac{r}{1-m} y - y^2}}, \quad m < 1.$$

In

In a conic section if A and B be the transverse and conjugate axes, L the *latus rectum*, y the distance of any point in the section from the focus, and p a perpendicular from thence upon a tangent to that point; then per conics $p =$

$\frac{\frac{1}{2} B y}{\sqrt{A y \pm y^2}}$ the positive or negative sign taking place according as the curve is an hyperbola or ellipse; but in the parabola, A being infinite, y^2 will vanish. Hence, because in this case

$m = \frac{n-1}{2} \times s^2 = \frac{1}{2} s^2$, it is evident that the first equation belongs to an hyperbola, A being =

$$\frac{r}{m-1} = \frac{2r}{s^2-2}, B = 2 \sqrt{\frac{m}{m-1}} \times P = \frac{2sP}{\sqrt{s^2-2}},$$

$$\text{and } L = \frac{B^2}{A} = \frac{4mP^2}{r} = \frac{2s^2P^2}{r}. \quad \text{Likewise}$$

$$\text{the perpendicular upon the asymptote} = \sqrt{\frac{m}{m-1}} \times P = \frac{sP}{\sqrt{s^2-2}}.$$

The second is an equation of the parabola; from whence it will appear that $\frac{\frac{1}{2}B}{A^{\frac{1}{2}}} = \frac{1}{2} \sqrt{L}$
 $= \frac{P}{r^{\frac{1}{2}}}$; therefore $\frac{1}{4} L = \frac{P^2}{r}$.

The third equation belongs to an ellipse; A being = $\frac{r}{1-m} = \frac{2r}{2-s^2}$, $B = 2 \sqrt{\frac{m}{1-m}}$
 $\times P =$

$$\times P = \frac{2sP}{\sqrt{2-s^2}}, \text{ and latus rectum } L = \frac{2s^2P^2}{r}$$

From what has been observed above it will evidently follow, that, if the centripetal force \propto [vary as] the square of the distance from the centre reciprocally, the curve described by the body will be a conic section, or circle.

All the common properties of bodies moving in conic sections may easily be deduced from the above equations; but that is not the intention of this Proposition.

COR. 3. If $n=3$, the values of p found in the Prop. will become

$$1. \quad p = \frac{\sqrt{\frac{m}{m-1}} \times Py}{\sqrt{y^2 + \frac{r^2}{m-1}}}, \quad m > 1$$

$$2. \quad p = \frac{P}{r} \times y, \quad m = 1.$$

$$3. \quad p = \frac{\sqrt{\frac{m}{1-m}} \times Py}{\sqrt{\frac{r^2}{1-m} - y^2}}, \quad m < 1.$$

And the respective values of z will be

$$1. \quad \dot{z} = \pm \frac{\sqrt{\frac{m}{m-1}} \times r P \dot{y}}{y \sqrt{y^2 + \frac{r^2 - mP^2}{m-1}}} = \pm \frac{\sqrt{\frac{m}{m-1}} \times P r \dot{y}}{y \sqrt{y^2 - \frac{mP^2 - r^2}{m-1}}},$$

$m > 1.$

2. $\dot{z} =$

$$2. \quad \dot{z} = \pm \frac{P r}{\sqrt{r^2 - P^2}} \times \frac{\dot{y}}{y}, \quad m=1.$$

$$3. \quad \dot{z} = \pm \frac{\sqrt{\frac{m}{1-m}} \times r P \dot{y}}{y \sqrt{\frac{r^2 - m P^2}{1-m} - y^2}}, \quad m < 1.$$

The first value of \dot{z} , in which m is greater than unity, may be subdivided into three others, according as $m P^2$ is greater, equal to, or less than r^2 .

1. If $m P^2$ be greater than r^2 , the equation for determining the apfides becomes $y^2 - \frac{m}{m-1} P^2 + \frac{r^2}{m-1} = 0$; wherefore $y = \sqrt{\frac{m P^2 - r^2}{m-1}}$, the curve therefore has an apse and two infinite legs.

By taking the correct fluent it will appear, that $z = \frac{r P \sqrt{\frac{m}{m-1}}}{m P^2 - r^2} \times$ the difference of two arcs whose secants are y and r , and radius = $\sqrt{\frac{m P^2 - r^2}{m-1}}$, = $\frac{\sqrt{m} \times P}{\sqrt{m P^2 - r^2}} \times$ the difference of two arcs whose secants are $\frac{\sqrt{m-1} \times r y}{\sqrt{m P^2 - r^2}}$ and $\frac{\sqrt{m-1} \times r^2}{\sqrt{m P^2 - r^2}}$, and radius = r ; hence the tra-

jectory,

jectory is easily constructed, by finding any number of points at pleasure.

If $P=r$, or the body be projected at right angles to a line drawn from the centre of force,

then $z = \sqrt{\frac{m}{m-1}} \times \text{arch whose secant} = y$, and

rad. $= r$. To construct the orbit upon this sup-

position; from the centre C , at the distance $CV=r$, (Fig. 2.) describe the circle VQS ;

take any arc VR , and draw the tangent RT ;

take $VQ : VR :: \sqrt{\frac{m}{m-1}} : 1 :: \sqrt{m} :$

$\sqrt{m-1} :: s : \sqrt{s^2-1}$, and draw CQ , which

produce to n ; making $Cn = CT$; then n will

be a point in the curve. If VQS be taken to

a quadrant in the above proportion, and CS

be produced indefinitely, it will be parallel to

an asymptote to the curve. This is too evident

to require any particular proof. From the

centre C draw CP perpendicular to CL , and

take it $= \sqrt{\frac{m}{m-1}} \times r = \frac{s r}{\sqrt{s^2-1}}$, and

through the point P draw PL parallel to CL ,

and it will be an asymptote to the curve or

trajectory.

The number of revolutions which the body

will make, while going from an apse to an

infinite distance, will evidently be equal to

$$\sqrt{\frac{\frac{m}{m-1}}{4} \times \text{quadrant}} = \frac{1}{4} \sqrt{\frac{m}{m-1}}.$$

$$2. \text{ If } m P^2 = r^2, \text{ then } p = \frac{\sqrt{\frac{r^2}{m-1}} \times y}{\sqrt{y^2 + \frac{r^2}{m-1}}},$$

the equation of the hyperbolic spiral; the body will therefore revolve in this curve, and will come to an apse at the centre. For at that time

$$y = \sqrt{\frac{m P^2 - r^2}{m-1}} = 0. \text{ It will likewise appear}$$

$$\text{that } z \pm \sqrt{\frac{m}{m-1}} \times r P \times \frac{\dot{y}}{y^2}; \text{ the correct}$$

$$\text{fluent therefore gives } x = \pm \sqrt{\frac{m}{m-1}} \cdot P \times$$

$$\frac{y-r}{y}, \text{ or } z = \sqrt{\frac{m}{m-1}} \cdot P \times \frac{y-r}{y}, \text{ when the body}$$

$$\text{ascends, and } z = \sqrt{\frac{m}{m-1}} \cdot P \times \frac{r-y}{y}, \text{ when it}$$

descends. If the body be infinitely distant from

$$\text{the centre, then } z = \sqrt{\frac{m}{m-1}} \times P. \text{ Hence if}$$

$c = 3.14159$, the number of revolutions which the body will describe in ascending to an infinite

$$\text{height from the distance } r, = \sqrt{\frac{m}{m-1}} \times P \div$$

$$2 c r = \sqrt{\frac{m}{m-1}} \times \frac{P}{2 c r} = \frac{1}{2 c \sqrt{\frac{m-1}{m}}} =$$

$$\frac{1}{2 c \sqrt{s^2 - 1}}, \text{ for } \sqrt{\frac{m}{m-1}} \times P = r. \text{ In descending}$$

ing to the centre, it is evident, that the number of revolutions will be infinite; for when $y = 0$, $\frac{r-y}{y} = \frac{r}{0}$, is infinite. The

distance of the asymptote from the centre =

$$\sqrt{\frac{m}{m-1}} \times P = \frac{r}{\sqrt{\frac{m}{m-1}}} = \frac{r}{\sqrt{s^2-1}}.$$

3, If $m P^2$ be less than r^2 , then the value of y , when the body arrives at an apse, = $\sqrt{\frac{m P^2 - r^2}{m-1}}$, becomes impossible; therefore

upon this supposition the body can never come to an apse. But it may either descend to the centre, or go off to an infinite distance, as is evident from the equation to the curve.

Because $\dot{z} = \pm \frac{\sqrt{\frac{m}{m-1}} r P \dot{y}}{y \sqrt{y^2 + \frac{r^2 - m P^2}{m-1}}}$, by taking

the fluent $z = \pm r P \sqrt{\frac{m}{r^2 - m P^2}} \times \log.$

$$\frac{\sqrt{y^2 + \frac{r^2 - m^2}{m-1}} + \sqrt{\frac{r^2 - m P^2}{m-1}}}{y},$$

and corrected $z = \pm r P \sqrt{\frac{m}{r^2 - m P^2}} \times \log.$

$$\frac{\sqrt{m \cdot r^2 - P^2} + \sqrt{r^2 - m P^2}}{\sqrt{m-1} \cdot y^2 + r^2 - m P^2 + \sqrt{r^2 - m P^2}} \times \frac{y}{r}.$$

If

If y be infinite, then $z = r P \sqrt{\frac{m}{r^2 - m P^2}} \times \log.$

$$\frac{\sqrt{m \cdot r^2 - P^2} + \sqrt{r^2 - m P^2}}{r \sqrt{m-1}}.$$

The body will

therefore go off to an infinite distance in a finite number of revolutions.

But if $y=0$, the value of the fraction

$$\frac{\sqrt{m \cdot r^2 - P^2} \times \sqrt{r^2 - m P^2}}{\sqrt{m-1} y^2 + r^2 - m P^2 + \sqrt{r^2 - m P^2}} \times \frac{y}{r}$$

is nothing, wherefore the body will make an infinite number of revolutions in descending to the centre. From the above equations the trajectory may be constructed.

Next, if $m=1$, the equation of the trajectory being $p = \frac{P}{r} \times y$, the curve in which the body

moves is the log. spiral. But $z = \pm \frac{P r}{\sqrt{r^2 - P^2}}$

$\times \frac{\dot{y}}{y}$, therefore $z = \frac{P r}{\sqrt{r^2 - P^2}} \times \log. \frac{y}{r}$ when

the body ascends, and $z = \frac{P r}{\sqrt{r^2 - P^2}} \times \log. \frac{r}{y}$

when it descends; wherefore, the body can neither descend to the centre, nor go off to an infinite distance in a finite number of revolutions. If $P=r$, or the body be projected at right angles to the line drawn from the centre, it is evident that it will describe a circle.

In the last case, when m is less than unity, the equation of the trajectory is $p =$

$$\frac{\sqrt{\frac{m}{1-m}} \times P y}{\sqrt{\frac{r^2}{1-m} - y^2}}, \text{ and } \dot{z} = \pm$$

$$\frac{\sqrt{\frac{m}{1-m}} \times r P \dot{y}}{y \sqrt{\frac{r^2 - m P^2}{1-m} - y^2}}. \text{ It is evident that when}$$

$y=0$, $p=0$; the body may therefore descend to

the centre; but if y be infinite, $p = \frac{\sqrt{\frac{m}{1-m}} \times P}{\sqrt{-1}}$;

therefore the body cannot ascend to an infinite height. It is likewise evident from the above equation, that when y increases, p increases; but p can never exceed y , therefore when they are equal, that is, at an apse, y will be the greatest possible; but then $y = \sqrt{\frac{r^2 - m P^2}{1-m}}$.

Wherefore, after the body has passed an apse, it will descend to the centre.

$$\text{Because } \dot{z} = \pm \frac{\sqrt{\frac{m}{1-m}} \times r P \dot{y}}{y \sqrt{\frac{r^2 - m P^2}{1-m} - y^2}}, \text{ the cor-}$$

rect fluent being taken, and the equation reduced

duced we have $z = r P \sqrt{\frac{m}{r^2 - m P^2}} \times$

$$\left(\begin{aligned} & \frac{\sqrt{\frac{r^2 - m P^2}{1-m}} - \sqrt{\frac{r^2 - m P^2}{1-m} - y^2}}{y} \\ & + \log. \frac{\sqrt{\frac{r^2 - m P^2}{1-m}} - \sqrt{\frac{r^2 - m P^2}{1-m} - r^2}}{r} \end{aligned} \right).$$

If $P = r$, or the body be projected from an apse, then $z = r \sqrt{\frac{m}{1-m}} \times \log. \frac{y}{r - \sqrt{r^2 - y^2}}$, and when $y = 0$, the value of the fraction

$\frac{y}{r - \sqrt{r^2 - y^2}}$ is infinite, as may be found either by taking the fluxions of the numerator and denominator, or by expanding $\sqrt{r^2 - y^2}$, and dividing y by the denominator; hence the body will make an infinite number of revolutions before it arrives at the centre.

The orbit may be constructed in the following manner. Let the rectangular hyperbole $V A$ (Fig. 3.) be described, whose centre is C and vertex V ; join $C A$, and draw the tangent $A T$ to the point A , and $A B$ perpendicular to the axis $V B$. Let $C V = r$, $C B = x$, and $C T = y$. It is well known that the fluxion of the sector

B b b 2

C V A

$CVA = \frac{r^2}{2} \times \frac{\dot{x}}{\sqrt{x^2 - r^2}}$; but $x:r::r:y$, there-

fore $x = \frac{r^2}{y}$, and $\dot{x} = -\frac{r^2 \dot{y}}{y^2}$, consequently

$$\frac{r^2}{2} \times \frac{\dot{x}}{\sqrt{x^2 - r^2}} = -\frac{r^2}{2} \times \frac{r^2 \dot{y}}{y \sqrt{\frac{r^4}{y^2} - r^2}} = -$$

$$\frac{r^3 \dot{y}}{2y \sqrt{r^2 - y^2}} = \text{fluxion of the sector } CVA.$$

But in this case $\dot{z} = -\frac{\sqrt{\frac{m}{1-m}} \times r^2 \dot{y}}{y \sqrt{r^2 - y^2}}$, there-

fore the fluxion of the circular sector $CVY = -$

$$\frac{\sqrt{\frac{m}{1-m}} \times r^3 \dot{y}}{2y \sqrt{r^2 - y^2}}. \quad \text{Take } \sqrt{\frac{m}{1-m}} : 1 :: \text{hy-}$$

perbolic sector : circular sector VCY , and make $Cp = CT$; then is p a point in the trajectory.

From this construction it will easily appear, that the number of revolutions which the body must make before it arrives at the centre will be infinite, because the area CVA increases without limit.

Or the trajectory may be constructed in the following manner. Describe the semicircle SVD (Fig. 4.) with the radius $CV = r$; draw AB perpendicular to CD , and suppose it equal to y , and take the arc $VQ =$ the difference
of

of the hyperbolic logarithms of AB and BD multiplied into $r\sqrt{\frac{m}{1-m}}$, and take $Cp = AB$; then is p a point in the trajectory, as will be evident from the equation $z = r\sqrt{\frac{m}{1-m}} \times \log. \frac{y}{r - \sqrt{r^2 - y^2}}$.

Because the ratio of AB to BD is infinitely great when AD is evanescent, the number of revolutions before the body arrives at the centre, must be infinite.

Cor. 4. If $n=4$, then, $p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{3}{2}}}{\sqrt{y^3 + \frac{r^3}{m-1}}}$,

$$\dot{z} = \pm \frac{\sqrt{\frac{m}{m-1}} \times r P y^{\frac{1}{2}} \dot{y}}{y \sqrt{y^3 - \frac{m}{m-1} \times P^2 y + \frac{r^3}{m-1}}}, \text{ and } y^3 - \frac{m}{m-1} P^2 y + \frac{r^3}{m-1} = 0,$$

is the equation for determining the apfides; where m may be greater than, equal to, or less than unity. The ratios of m to unity, and of P to r being given, it will be easy to determine when all the roots of this last equation are real, and when two of them are impossible. If the body be projected from an apse, or $P=r$, then all the
the

the roots are real, two being positive and one negative, which belongs to a part of the curve having its concavity turned from the centre of force.

$$\text{If } n = 5, \text{ then } p = \frac{\sqrt{\frac{m}{m-1}} \times P y^2}{\sqrt{y^4 + \frac{r^4}{m-1}}} =$$

$$\frac{\sqrt{m} \times P y^2}{\sqrt{m-1} \cdot y^4 + r^4}, \dot{z} = \frac{\sqrt{\frac{m}{m-1}} r P y \dot{y}}{y \sqrt{y^4 - \frac{m}{m-1} P^2 y^2 + \frac{r^4}{m-1}}}$$

and $y^4 - \frac{m}{m-1} P^2 y^2 + \frac{r^4}{m-1} = 0$, is the equation for determining the apsidal distances; here, like-

wise, m may be greater than, equal to, or less than unity. The several parts of this curve might easily be traced out when m is greater or less than unity, but notice will only be taken of that case in which $m = 1$, or the body is projected with the same velocity as it would acquire by falling from an infinite height. In

this case $p = \frac{P}{r^2} \times y^2$, an equation to a circle, the centre of force being in the circumference, and the diameter $= \frac{r^2}{P}$. For, let C in the

circumference of the circle AVC , be the centre of force, CA the diameter (Fig. 5.) V the point from

from which the body is projected, n any other place in the circle; draw the tangents VP , np , and the perpendicular CP , Cp , and join V , A , and n , A . Then by similar triangles $CP : CV$

$$:: CV : CA, \text{ that is, } P : r :: r : CA = \frac{r^2}{P}; \text{ and}$$

$$Cp : Cn :: Cn : CA; \text{ that is, } p : y :: y : \frac{r^2}{P}, \text{ there-}$$

$$\text{fore, } p = \frac{P}{r^2} \times y^2.$$

It will easily appear, that upon this supposition, the periodic times in different circles would be as the cubes of their diameters directly; taking it for granted that a revolution were possible.

COR. 5. If $n = 1$, or the force be directly as the distance, then, $m = \frac{n-1}{2} \times s^2 = -s^2$;

$$\text{hence because in general, } p = \frac{\sqrt{\frac{m}{m-1}} \times P y^{\frac{n-1}{2}}}{\sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}$$

$$\text{therefore by substitution and reduction } p = \frac{s P r}{\sqrt{s^2 + 1} \times r^2 - y^2}, \text{ and } \dot{z} =$$

$$\frac{s P r^2 \dot{y}}{y \sqrt{-y^4 + s^2 + 1} \cdot r^2 y^2 - s^2 P^2 r^2}.$$

The above is an equation to an ellipse, the centre of

of force being in its centre. For, if $2R =$ the transverse, and $2C =$ the conjugate axis, $y =$ the distance from the centre, and $p =$ the perpendicular

upon the tangent, then $p = \frac{CR}{\sqrt{R^2 + C^2 - y^2}}$.

Compare this with the above equation, and it will easily appear, that $2R = \sqrt{s^2 + 1} \cdot r^2 + 2sPr$ + $\sqrt{s^2 + 1} \cdot r^2 - 2sPr$, and $2C = \sqrt{s^2 + 1} \cdot r^2 + 2sPr - \sqrt{s^2 + 1} \cdot r^2 - 2sPr$. The same conclusion may likewise be deduced from the equation for determining the apses, which has two roots positive, and two equal to them and negative.

COR. 6. If $m = 1$, then $s^2 = \frac{2}{n-1}$; which, if n be greater than 3, is less than unity, and the body in this case must fall to the centre; and the number of revolutions it will make before it arrives there, may be determined in the following manner. In this case $p =$

$$\frac{P}{r^{\frac{n-1}{2}}} \times y^{\frac{n-1}{2}} = \frac{y^{\frac{n-1}{2}}}{r^{\frac{n-3}{2}}} \text{ when } P = r, \text{ or the}$$

body moves from an apse; therefore $p : y :: y^{\frac{n-3}{2}} : r^{\frac{n-3}{2}}$. But when y and p are evanescent,

$r^{\frac{n-3}{2}}$ is infinitely greater than p , and consequently at that time the angle $n C p$ (Fig. 1.) will be a right angle. From the equation of the

the curve it will easily appear that $\frac{\dot{p}}{p} = \frac{n-1}{2} \times \frac{\dot{y}}{y}$. Let A , and a represent the angles described by Cp , and Cn , respectively since the body left an apse; then, because $\dot{A} : \dot{a} :: \frac{\dot{p}}{y} : \frac{\dot{y}}{y} *$
 $:: \frac{n-1}{2} : 1$; $\dot{A} = \frac{n-1}{2} \times \dot{a}$, and $A = \frac{n-1}{2} a$;
 for A and a begin together. But $A = 2 + a$
 when $y = 0$, or the body arrives at the centre;
 C c c hence

* If a body revolve in a curve of any kind round a centre of force; to compare the angular velocity of the perpendicular upon the tangent with that of the distance from the centre, or radius vector.

Let PQW (Fig. 6.) be the curve in which the body moves, S the centre of force, and C the centre of curvature. Let P , Q be two points in the curve indefinitely near to each other, to which the tangents PY , Qy are drawn; let fall the perpendiculars SY , Sy , and QT , which last may be taken for the arch of a circle described from the center S . It is evident that the angles

PSQ , PCQ are to each other as $\frac{QT}{SP} : \frac{PQ}{CP} :: \frac{SY}{SP_1}$
 $: \frac{SP}{CP}$ (by similar triangles) $:: \frac{p}{y} : \frac{y}{CP}$. But $CP =$
 $\frac{y\dot{y}}{\dot{p}}$, and the angle $PCQ = YSy$, therefore the angle
 $PSQ : YSy :: \frac{p}{y} : y \div \frac{y\dot{y}}{\dot{p}} :: \frac{\dot{y}}{y} : \frac{\dot{p}}{p}$.

hence we have $a = \frac{2}{n-3} \times \mathcal{Q} = \frac{1}{2 \times n-3} \times$

C , \mathcal{Q} being a quadrant, and $C =$ the circumference of a circle whose radius $= r$. The number of revolutions therefore $= \frac{1}{2 \times n-3}$.

If n be less than 3, s must be greater than unity; therefore the body projected at right angles to a line drawn from the centre of force, and with a greater velocity than would make it describe a circle, it must begin to ascend; and it must ever continue rising, as its velocity is equal to that acquired by falling from an infinite

height. Because $p : y :: r^{\frac{3-n}{2}} : y^{\frac{3-n}{2}}$, therefore when y is infinite, p is finite, and hence the angle pCp , at that time is a right angle.

As above, $A = \frac{n-1}{2} \times a$, and $a = \mathcal{Q} + A$, there-

fore $a = \frac{2}{3-n} \times \mathcal{Q} = \frac{1}{2 \cdot 3-n} \times C$. Hence

the number of revolutions the body describes in ascending to an infinite height $= \frac{1}{2 \times 3-n}$.

SCHOLIUM.

Because $\frac{v}{s} =$ velocity in a circle at the distance r from the centre, and if the force ∞

$\frac{1}{y^n}$, the velocities in circles will $\propto \frac{1}{y^{\frac{n-1}{2}}}$

(Princip. Prop. 4.) consequently $\frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}$

= velocity in a circle at the distance y from the centre. But $\frac{Pv}{p}$ = velocity in the trajectory at the distance y ; if, therefore, we make

$$\frac{Pv}{p} = \frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}, \text{ and at the same}$$

time the body be supposed to arrive at an apse, in which case $p^2 = y^2 =$

$$\frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}, \text{ it would continue to move}$$

for ever in this circle. But coming to an apse, it must ascend or descend in a similar and equal curve, hence it never can arrive at the distance y from the centre, determined from the above equations, in any finite number of revolutions.

Making, therefore, as above $\frac{Pv}{p} =$

$$\frac{r^{\frac{n-1}{2}}}{y^{\frac{n-1}{2}}} \times \frac{v}{s}, \text{ we have } p^2 = P^2 s^2 \times \frac{y^{n-1}}{r^{n-1}} =$$

$$\frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}, \text{ hence, } s^2 = \frac{\frac{m}{m-1} \times r^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}}.$$

$$\text{But because } p^2 = y^2 = \frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} \times \frac{r^{n-1}}{m-1}},$$

$$y^{n-1} + \frac{r^{n-1}}{m-1} = \frac{m}{m-1} \times P^2 y^{n-3}; s^2 P^2 = \frac{r^{n-1}}{y^{n-3}}. \text{ But the equation for determining}$$

$$\text{the apfides is } y^{n-1} - \frac{m}{m-1} P^2 y^{n-3} + \frac{r^{n-1}}{m-1} = 0,$$

$$\text{or } y^{n-1} - \frac{n-1}{n-1 \cdot s^2 - 2} \times s^2 P^2 y^{n-3} +$$

$$\frac{2 r^{n-1}}{n-1 \cdot s^2 - 2} = 0; \text{ whence by substitution we}$$

$$\text{have } y^{n-1} - \frac{n-1 \cdot r^{n-1}}{n-1 \cdot s^2 - 2} + \frac{2 r^{n-1}}{n-1 \cdot s^2 - 2}$$

$$= 0, \text{ or } y^{n-1} = \frac{n-3}{n-1 \cdot s^2 - 2} \times r^{n-1}, \text{ there-}$$

$$\text{fore } y = \frac{n-3}{n-1 \cdot s^2 - 2} \left| \frac{1}{n-1} \right| \times r = \frac{n-3}{2m-2} \left| \frac{1}{n-1} \right|$$

$$\times r,$$

$\times r$, because $\frac{2m}{n-1} = s^2$. It is evident from inspection, that n must be greater than 3 and m greater than unity; the force therefore must vary in an higher proportion than the cube of the distance inversely. If the body descend from the point v , then $s^2 = \frac{r^{n-1}}{P^2 y^{n-3}}$, must be greater than unity. If it ascend, then $n-3$ must be greater than $n-1 \times s^2 - 2$, and therefore s^2 , and consequently s , less than unity.

From the above equations and observations, we have the following construction. (Fig. 7.) Let C be the centre of force, V the point from which the body is projected in the direction VP , which makes an acute angle with CV , and with a velocity greater than would make it move in the circle vzu if projected at right angles. With the centre C and radius $Ca =$

$$\frac{1}{\frac{n-1}{n-1 \cdot s^2 - 2}} \left| \frac{1}{n-1} \right. \times r \text{ describe the circle } abd,$$

and from C upon VP let fall the perpendicular

$$CP, \text{ making it equal to } \frac{r^{\frac{n-1}{2}}}{s \times Ca \frac{n-3}{2}}. \text{ Then,}$$

from what has been determined in this Scholium, it will be evident, that the body will move in
the

the curve VW , to which VP is a tangent, continually descending towards the circle abd , but will never arrive at it in any finite number of revolutions. This circle is therefore an asymptote to the trajectory.

In the same manner, if s be less than unity, or the velocity with which the body is projected in a line VT , which makes an acute angle with VA , be less than the velocity of a body in the circle VUZ ; then with the centre C

and radius $CA = \frac{n-3}{n-1 \cdot s^2 - 2} \left| \frac{1}{n-1} \right| \times r$ de-

scribe the circle ABD , and from C upon TV produced let fall the perpendicular CP , which

make equal to $\frac{r^{\frac{n-1}{2}}}{s \times CA^{\frac{n-3}{2}}}$; then the body,

will continually ascend from the centre, but will never arrive at the circle ABD . This circle, therefore, is likewise an asymptote to the curve in which the body moves,

Hence, if a body be projected from any point, and descend towards the centre, the velocity with which it is projected must be greater than either that which it would acquire in falling from an infinite height to that point, or than that of a body describing the circle at
the

the distance of that place from the centre of force. If it ascend, the velocity must be greater than that acquired by descending from an infinite height, but less than that of a body in a circle at that distance. Within these limits the construction is general.

PROPOSITION II.

THE same things being given as in the last proposition; to determine the velocity and time corresponding to any given distance of the body from the centre of force.

Let the velocities of bodies in a circle at the distance r in the curve, at V and n , be $= V, v$ and \dot{u} respectively (Fig. 1.); then $\dot{u} = \frac{Pv}{p}$. If therefore the several values of p , depending upon the different values of m , be substituted, we shall have

$$1. \dot{u} = \frac{v \sqrt{y^{n-1} + \frac{r^{n-1}}{m-1}}}{\sqrt{\frac{m}{m-1}} \times \frac{y^{n-1}}{2}} = v \sqrt{\frac{m-1 \times y^{n-1} + r^{n-1}}{m \times y^{n-1}}},$$

m being greater than 1.

$$2. \dot{v} = v \sqrt{\frac{r^{n-1}}{y^{n-1}}} \quad m = 1.$$

$$3. \dot{v} = \frac{v \sqrt{\frac{r^{n-1}}{1-m} - y^{n-1}}}{\sqrt{\frac{m}{1-m} \times y^{\frac{n-1}{2}}}} = v \sqrt{\frac{r^{n-1} - 1 - m \cdot y^{n-1}}{m \cdot y^{n-1}}}$$

m being less than 1.

$$4. \dot{v} = \frac{V \sqrt{r^{n-1} - y^{n-1}}}{\sqrt{\frac{n-1}{2} \times y^{\frac{n-2}{2}}}}, \quad m = 0, \text{ therefore}$$

$$v = 0.$$

$$\text{If } n = 1, \text{ then } \dot{v} = v \sqrt{1 + \frac{2}{s^2} \times \log. \frac{r}{y}}.$$

$$\text{In the 4th value of } \dot{v}, \quad m = 0 = s^2 \times \frac{n-1}{2},$$

$$v : V :: s : 1; \text{ therefore } sV = v; \text{ hence } \frac{m}{1-m} =$$

$$\frac{s^2 \times \frac{n-1}{2}}{2 - s^2 \times \frac{n-1}{2}}, \text{ and } \frac{v}{\sqrt{\frac{m}{1-m}}} = \frac{V}{\sqrt{\frac{n-1}{2}}}$$

s being $= 0$, therefore the 4th. form is evident from the 3d. Because $m = s^2 \times \frac{n-1}{2}$, and

$$s^2 = \frac{v^2}{V^2}, \text{ therefore } m = \frac{v^2}{V^2} \times \frac{n-1}{2}; \text{ which}$$

value of m being substituted for it in the first equation gives, when reduced

$$\dot{v} =$$

$$\dot{v} = \sqrt{v^2 - 2 V^2 \times \frac{y^{n-1} - r^{n-1}}{n-1 \times y^{n-1}}} =$$

$$\sqrt{v^2 + 2 V^2 \times \frac{r^{n-1} - y^{n-1}}{n-1 \times y^{n-1}}}. \text{ Let } g = \text{force}$$

of gravity, and suppose the force at V , or at the distance r from the centre of force: force of gravity (g) :: $1 : 1$, then $lg = \text{force at } V$, measured by the velocity in the time (1);

hence, $\frac{V^2}{r} = lg$, or $V^2 = lgr$, therefore by sub-

stitution $\dot{v} = \sqrt{v^2 - 2 lgr \times \frac{y^{n-1} - r^{n-1}}{n-1 \times y^{n-1}}} =$

$$\sqrt{v^2 + 2 lgr \times \frac{r^{n-1} - y^{n-1}}{n-1 \times y^{n-1}}}. \text{ When } n=1, \text{ if}$$

the above value of s^2 be substituted we have

$$v = \sqrt{v^2 + 2 lgr \times \log. \frac{r}{y}} = \sqrt{v^2 - 2 lgr \times \log. \frac{y}{r}}.$$

Because P does not enter into the values of \dot{v} , it is evident that the velocity of the body will be the same, whether it move in a curve line, or directly to or from the centre; the distance of y being the same in both cases.

By the help of the 4th. theorem, it will be easy to determine how far a body must fall towards the centre, to acquire the velocity it has in the curve. For the value of \dot{v} there

D d d

given

given being put $= v = sV$, we shall have by

$$\text{reduction } y = r \times \frac{2}{s^2 \times n-1 + 2} \Big| \frac{1}{n-1} \text{ and the}$$

$$\text{space descended } r - y = r \times$$

$$\frac{s^2 \times n-1 + 2 \Big| \frac{1}{n-1} - 2 \frac{1}{n-1}}{s^2 \times n-1 + 2 \Big| \frac{1}{n-1}}.$$

If $n = 2$, then $r - y = \frac{s^2}{s^2 + 2} \times r$, which is general for all the conic sections. In the hyperbola, the transverse axis $= \frac{2r}{s^2 - 2}$, suppose, to A (see Cor. 2. Prop. 1.), therefore $s^2 = \frac{2A + 2r}{A}$; hence by substitution $r - y = \frac{A + r}{2A + r} \times r$.

In the parabola, $r - y = \frac{s^2}{s^2 + 2} = \frac{1}{2}r$, s^2 being in this case $= 2$,

In the ellipsis, $r - y = \frac{Ar}{2A - r} \times r$, the transverse axis being $\frac{2r}{2 - s^2} = A$.

If

If the body be supposed to move in a circle, and therefore $s=1$, then $r-y=$

$$\frac{\frac{1}{n+1} \frac{1}{n-1} - 2 \frac{1}{n-1}}{\frac{1}{n+1} \frac{1}{n-1}} \times r = \left(1 - \frac{2}{n+1} \right) \frac{1}{n-1} \times r.$$

If $n=2$, then $r-y=\frac{1}{3}r$.

If it be required to find how high a body will ascend, if projected upwards with the velocity it has in the curve; or how far it must fall externally, to acquire that velocity, put the value of \dot{u} , in the third theorem, $=0$, then y^{n-1}

$$= \frac{r^{n-1}}{1-m} = \frac{2 r^{n-1}}{2-s^2 \cdot n-1}, \text{ and } y = r \times$$

$$\frac{1}{\frac{2}{2-s^2 \cdot n-1} \frac{1}{n-1}}.$$

If $n=2$, then $y = r \times \frac{2}{2-s^2} = A$, the greater axis of the ellipse.

$$\text{If } s=1, \text{ then } y = r \times \frac{2}{2-s^2} = 2r.$$

Lastly, when m is greater than unity, it may be determined by the first theorem, what proportion the velocity in the curve bears to that velocity, towards which it continually approaches as the body recedes indefinitely from the centre. For, if y be supposed infinite,

then \dot{v} will become $= \frac{v}{\sqrt{\frac{m}{m-1}}} = \frac{v}{\sqrt{\frac{s^2 \cdot n-1}{s^2 \cdot n-1-2}}}$

Hence the velocity in the curve : velocity at an

infinite distance ; : $v : \frac{v}{\sqrt{\frac{s^2 \cdot n-1}{s^2 \cdot n-1-2}}} ::$

$\sqrt{\frac{s^2 \times n-1}{s^2 \cdot n-1-2}} : 1$. In the hyperbola,

that is, when $n=2$, the proportion will be

$\sqrt{\frac{s^2}{s^2-2}} : 1 :: \sqrt{A+r} : \sqrt{r}$; A being

equal the transverse axis.

Let t = time of moving from V to n , x = curve line Vn (Fig. 1.); then $\sqrt{y^2-p^2} : y ::$

$\dot{y} : \dot{x} = \frac{y \dot{y}}{\sqrt{y^2-p^2}}$. But $\dot{v} : \dot{x} :: 1 : t = \frac{\dot{x}}{\dot{v}}$

$= \frac{p \dot{x}}{Pv}$, because $\dot{v} = \frac{Pv}{p}$; therefore $t = \pm$

$\frac{p y \dot{y}}{Pv \sqrt{y^2-p^2}}$, in which expression, if the

several values of p be substituted, we shall have

1. $t = \pm \frac{\sqrt{\frac{m}{m-1}} \times y^{\frac{n-1}{2}} \dot{y}}{v \sqrt{y^{n-1} - \frac{m}{m-1} P^2 y^{n-3} + \frac{r^{n-1}}{m-1}}}$,

m being greater than 1.

2.

$$2. \dot{t} = \pm \frac{y^{\frac{n-1}{2}} \dot{y}}{v \sqrt{r^{n-1} - P^2 y^{n-3}}}, \quad m=1.$$

$$3. \dot{t} = \pm \frac{\sqrt{\frac{m}{1-m}} \times y^{\frac{n-1}{2}} \dot{y}}{v \sqrt{\frac{r^{n-1}}{1-m} - \frac{m}{1-m} P^2 y^{n-3} - y^{n-1}}},$$

m being less than 1.

$$4. \dot{t} = \pm \frac{\sqrt{\frac{n-1}{2}} \times y^{\frac{n-1}{2}} \dot{y}}{V \sqrt{r^{n-1} - y^{n-1}}}, \quad P = v, \\ v = 0 \quad \text{and} \quad m = 0.$$

The 4th. theorem is found by making the same substitution as before.

Cor. 1. If $n=2$, the several values of \dot{t} will become

$$1. \dot{t} = \pm \frac{\sqrt{\frac{m}{m-1}} \times y \dot{y}}{v \sqrt{y^2 \times \frac{r}{m-1} y - \frac{m}{m-1} P^2}},$$

m being greater than 1.

$$2. \dot{t} = \pm \frac{y \dot{y}}{v \sqrt{r y - P^2}}, \quad m = 1.$$

$$3. \dot{t} = \pm \frac{\sqrt{\frac{m}{1-m}} \times y \dot{y}}{v \sqrt{-\frac{m}{1-m} P^2 \times \frac{r}{1-m} y - y^2}},$$

m being less than 1.

4.

$$4. \dot{t} = \pm \frac{\sqrt{\frac{1}{2}} \times y \dot{y}}{V \sqrt{r y - y^2}} = \frac{\sqrt{\frac{1}{2}} \times y \dot{y}}{\sqrt{lg r} \times \sqrt{r y - y^2}},$$

$$P = 0, \quad m = 0.$$

The fluents in all these cases may be found by circular arcs and logarithms.

The correct fluent being taken for the 4th.

$$\text{form, gives } t = \frac{1}{V \sqrt{\frac{1}{2}}} \times \left(\sqrt{r y - y^2} + \text{arc} \right)$$

whose versed sine $= r - y$ and $\text{rad.} = \frac{1}{2} r =$

$$\frac{1}{\sqrt{2 \lg r}} \times \left(\sqrt{r y - y^2} + \text{arc} \right), \text{ versed sine}$$

$= r - y$ and $\text{rad.} = \frac{1}{2} r$; and when the body

$$\text{is fallen to the centre, then } t = \frac{1}{\sqrt{2 \lg r}} \times \frac{p r}{2}$$

; p . being $= 3.141592$.

COR. 2. If $n = 3$, the values of \dot{t} will become,

$$1. \dot{t} = \pm \frac{\sqrt{\frac{m}{m-1}} \times y \dot{y}}{v \sqrt{y^2 + \frac{r^2 - m P^2}{m-1}}}, \quad m > 1.$$

$$2. \dot{t} = \pm \frac{y \dot{y}}{v \sqrt{r^2 - P^2}}, \quad m = 1.$$

$$3. \dot{t} = \pm \frac{\sqrt{\frac{m}{1-m}} \times y \dot{y}}{v \sqrt{\frac{r^2 - m P^2}{1-m} - y^2}}, \quad m < 1.$$

$$4, \dot{t} = - \frac{y \dot{y}}{V \sqrt{r^2 - y^2}} = - \frac{y \dot{y}}{\sqrt{lg r} \times \sqrt{r^2 - y^2}}$$

$$P = 0, m = 0.$$

Hence by taking the correct fluents there will arise

$$1. t = \frac{1}{v} \sqrt{\frac{m}{m-1}} \times \left(\pm \sqrt{y^2 + \frac{r^2 - m P^2}{m-1}} \right. \\ \left. \mp \sqrt{\frac{m}{m-1} \times r^2 - P^2} \right), m > 1.$$

$$2. t = \frac{1}{2v} \times \frac{\pm y^2 \mp r^2}{\sqrt{r^2 - P^2}}, m = 1.$$

$$3. t = \frac{1}{v} \sqrt{\frac{m}{1-m}} \times \left(\mp \sqrt{\frac{r^2 - m P^2}{1-m} - y^2} \right. \\ \left. \pm \sqrt{\frac{m}{1-m} \times r^2 - P^2} \right), m < 1.$$

$$4. t = \frac{1}{V} \times \sqrt{r^2 - y^2} = \frac{r}{V} = \frac{r}{\sqrt{lg r}} = \\ \frac{r^{\frac{1}{2}}}{\sqrt{lg}}, \text{ when } y = 0, m = 0.$$

Consequently at the end of any given time, the place of the body may be found. For, from the equations given above, the value of y may be found if t be known, and y being known, z , or the arc VY will be given.

If the time of moving over any given space in a right line directly from, or towards the
centre

centre be required, it will immediately be found by making $P=0$ in the three first of the above theorems.

PROPOSITION III.

IF a body be acted upon by two forces tending to the same centre, which vary as the n th. and the q th. powers of the distance reciprocally; it is required to determine the equation of the orbit it will describe, &c.

Suppose the whole force acting upon the body, at the distance y from the centre, to be $= \frac{A^{n+1}}{y^n} + \frac{B^{q+1}}{y^q}$; hence, by proceeding as in

the first Proposition, we shall have $\frac{p^2 v^2}{2 p^2} - \frac{v^2}{2} =$

$$\frac{A^{n+1}}{n-1 \times r^{n-1}} \times \frac{r^{n-1} - y^{n-1}}{y^{n-1}} + \frac{B^{q+1}}{q-1 \cdot r^{q-1}} \times$$

$$\frac{r^{q-1} - y^{q-1}}{y^{q-1}}. \text{ Let } \frac{2 m B^{q+1}}{q-1 \cdot r^{q-1}} = v^2, \text{ then}$$

$$\text{there arises } \frac{p^2}{p^2} - 1 = \frac{r^{n-1} - y^{n-1}}{m \times y^{n-1}} +$$

$$\frac{r^{q-1} - y^{q-1}}{m \times y^{q-1}}. \text{ Hence by reduction it will ap-}$$

pear

pear that

$$p^2 = \frac{mm P^2 y^{n-1}}{mm - m - m \times y^{n-1} + mr^{q-1}y^{n-q} + mr^{n-1}}$$

$$\frac{mm P^2 y^{q-1}}{mm - m - m \times y^{q-1} + m r^{n-1} y^{q-n} + m r^{q-1}}$$

Suppose $\frac{B^{q+1}}{r^q} = \frac{A^{n+1}}{r^n}$, then since $\frac{2 m A^{n+1}}{n-1 \times r^{n-1}}$

$$= (v^2 =) \frac{2 m B^{q+1}}{q-1 \times r^{q-1}}; \frac{m A^{n+1}}{n-1} =$$

$$\frac{c m A^{n+1} \times r^{q-n}}{q-1 \times r^{q-n}}, \text{ or, } \frac{m}{n-1} = \frac{c m}{q-1}; \text{ hence}$$

$$m = \frac{q-1 \times m}{c \times n-1}.$$

If therefore this value of m , be substituted in the above value of p^2 , there will arise for the general equation of the curve

$$p^2 = \frac{m P^2 y^{n-1}}{r^{n-1} + c \times \frac{n-1}{q-1} r^{q-1} y^{n-q} + m-1 - c \times \frac{n-1}{q-1} y^{n-1}}$$

If p be supposed $=y$, then the equation for determining the distance of the apsides from the centre of force will become $y^{n-1} +$

$$\frac{c \times n-1 r^{q-1}}{m-1 \times q-1 - c \times n-1} y^{n-1}$$

E c e

—m

$$\begin{aligned}
 & - \frac{m \times \overline{q-1} \times P^2}{\overline{m-1} \times \overline{q-1} - c \times \overline{n-1}} y^{n-3} \\
 & + \frac{\overline{q-1} \times r^{n-1}}{\overline{m-1} \times \overline{q-1} - c \times \overline{n-1}} = 0.
 \end{aligned}$$

The value of z will be found by an easy substitution.

After the same manner the equation of the curve, &c. &c. may be found, if three or more forces act upon a body towards the same centre.

COR. If $n=2$, $q=-1$, $r=P$, and the force $\frac{Bq+1}{y^q}$, be supposed to act from the centre, or, which is the same thing, $-c$ be put for $+c$; then the equation for determining the distance of the apfides from the centre will become $y^4 - \frac{2+c-2m}{c} r^2 y^2 + \frac{2r^3}{c}$

$y - \frac{2m r^3}{c} = 0$. It is evident that one of the

values of y will be $=r$, and the equation given above being divided by $y-r$, the quotient will be $y^3 + ry - \frac{2-2m}{c} \times r^2 y +$

$\frac{2m}{c} r^3 = 0$; by solving which equation, the distance of the other apse from the centre may be determined.

If

If it be required to exterminate m , we have

$$\frac{v^2}{s^2} \times \frac{1}{r} = \frac{A^{n+1}}{r^n} + \frac{B^{q+1}}{r^q} \text{ (Proposition I.) or}$$

$$v^2 = s^2 \times \left(\frac{A^{n+1}}{r^{n-1}} + \frac{B^{q+1}}{r^{q-1}} \right) = \frac{2 m A^{n+1}}{n-1 \times r^{n-1}} ;$$

$$\text{and, by this Proposition, } B^{q+1} = \frac{c A^{n+1}}{r^{n-q}}, \text{ there-}$$

$$\text{fore } s^2 \times \frac{1}{1+c} = \frac{2 m}{n-1}, \text{ or } m =$$

$$\frac{s^2 \times \frac{n-1}{2} \times \frac{1}{1+c}}{2} = \frac{s^2 \times \frac{1}{2} \times \frac{1}{1-c}}{2} \text{ in this Cor.}$$

wherefore, by substituting this value in the above

$$\text{equation, we have } y^3 + r y^2 - \frac{2 - s^2 \times \frac{1-c}{c}}{c} r^2 y$$

$$+ \frac{s^2 \times \frac{1-c}{c}}{c} r^3 = 0. \text{ But } \dot{z} = \frac{r p \dot{y}}{y \sqrt{y^2 - p^2}} =$$

$$\frac{\sqrt{2 m \times r^3 \dot{y}}}{y \sqrt{c y^4 - 2 + c - 2 m \times r^2 y^2 + 2 r^3 y - 2 m r^4}} =$$

$$\frac{s \sqrt{1-c} \times r^3 \dot{y}}{y \sqrt{c y^4 - 2 + c - s^2 \times \frac{1-c}{c} \times r^2 y^2 + 2 r^3 y - s^2 \times \frac{1-c}{c} r^4}} ;$$

if the fluent therefore be taken, when y = the distance of the other apse from the centre, the arc described in passing from one apse to ano-

ther, and consequently the *motion* of the apsidæ will be found; whatever be the form of the orbit. Hence it is evident, that if s and c be given, the eccentricity of the orbit and the motion of the apsidæ may be calculated.

PROPOSITION IV.

THE centripetal force being reciprocally as the n th. power of the distance from a plane parallel to the horizon, and the direction and velocity of a body at any point being given; it is required to determine the nature of the curve it will describe.

Let a = distance of the point at which the body is projected from the horizontal plane, b = velocity parallel to, and c = velocity perpendicular to the plane, x = any abscissa, y = the corresponding ordinate, and z the curve described; then $\dot{x} : \dot{z} :: b : \frac{b\dot{z}}{\dot{x}}$ = velocity of the body in the curve. The force in direction of the ordinate is = the square of the velocity divided by $\frac{1}{2}$ chord of curvature perpendicular to the horizon, or passing through the centre of force. But $\frac{1}{2}$ chord of curvature when \dot{x} is constant, which is the case

case at present, $= -\frac{\dot{z}^2}{y}$; therefore the centri-

$$\text{petal force} = \frac{b^2 \dot{z}^2}{\dot{x}^2} \div -\frac{\dot{z}^2}{y} = -\frac{b^2 y}{\dot{x}^2} = ,$$

suppose, to $\frac{A^{n+1}}{y^n}$. Multiply both sides of the

equation by \dot{y} , and take the fluents, then $\frac{b^2}{2} \times$

$$\frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{n-1} \times \frac{1}{y^{n-1}}. \text{ But } \dot{x} : \dot{y} :: b : c, \text{ or } \frac{\dot{y}^2}{\dot{x}^2}$$

$$= \frac{c^2}{b^2}, \text{ when } y=r, \text{ therefore the fluents cor-}$$

$$\text{rected become } \frac{c^2}{2} - \frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{n-1} \times$$

$$\frac{y^{n-1} - r^{n-1}}{r^{n-1} \times y^{n-1}}; \text{ which gives}$$

$$\dot{x} = \frac{b \sqrt{n-1} \times r^{\frac{n-1}{2}} \cdot \dot{y}^{\frac{n-1}{2}} \dot{y}}{\sqrt{n-1} c^2 r^{n-1} - 2 A^{n+1} y^{n-1} + 2 A^{n+1} r^{n-1}}$$

But in Prop. I. it was found, that if a body descended from an infinite height, and was

acted upon by a force $= \frac{A^{n+1}}{y^n}$, the square of

the velocity acquired at the distance r was $=$

$$\frac{2 A^{n+1}}{n-1 \times r^{n-1}}; \text{ let therefore } \frac{2 m A^{n+1}}{n-1 \times r^{n-1}} = c^2,$$

and

and then $A^{n+1} = \frac{n-1 \times c^2 r^{n-1}}{2m}$. Hence, by

substitution and reduction, $\ddot{x} = \frac{b}{c} \times$

$$\frac{\sqrt{m} \times y^{\frac{n-1}{2}} \dot{y}}{\sqrt{m-1} \times y^{n-1} + r^{n-1}};$$

from whence the relation of x and y may be determined.

Let V = velocity of a body in a circle at the distance r from the centre of force, and which is acted upon by the same force as that which tends towards the plane at the same distance from it; then $\frac{V^2}{r} = \frac{A^{n+1}}{r^n}$, or $A^{n+1} = V^2 \times r^{n-1}$; from whence, and the equation above,

viz. $A^{n+1} = \frac{n-1 \times c^2 r^{n-1}}{2m}$, it will easily appear,

that $c = \frac{\sqrt{2m} \times V}{\sqrt{n-1}}$; therefore the above equa-

tion becomes $\ddot{x} = \frac{b \sqrt{n-1}}{V \times \sqrt{2}} \times$

$$\frac{y^{\frac{n-1}{2}} \dot{y}}{\sqrt{m-1} \times y^{n-1} + r^{n-1}}$$

COR. 1. If c , and consequently $m = 0$, or, which is the same thing, if the body be projected parallel to the horizon, then $\ddot{x} =$

$$\frac{b \sqrt{n-1}}{V \times \sqrt{2}} \times \frac{y^{\frac{n-1}{2}} \dot{y}}{\sqrt{r^{n-1} - y^{n-1}}}.$$

COR. 2. If $n = 3$, then the last equation in the proposition becomes $\dot{x} = \frac{b}{v} \times \frac{y \dot{y}}{\sqrt{m-1} \times y^2 + r^2}$.

The fluent therefore being taken and corrected, by supposing x and y to begin together, we have $x = \frac{b}{v} \times \frac{m-1 \times y^2 + r^2|^{\frac{1}{2}} - r}{m-1}$; there-

fore, by reduction, $y^2 = \frac{r^2}{m-1} \times \frac{V^2}{b^2} x^2 + \frac{2V}{b} r x = \frac{2V}{b} r x - \frac{1}{1-m} \times \frac{V^2}{b^2} x^2$, an equation to a co-

nic section; which will be an hyperbola, parabola to ellipsis, according as m is greater, equal to, or less than unity; that is, according as the velocity with which the body is projected in a direction perpendicular to the horizon, is greater, equal to, or less than that acquired by falling from an infinite height.

If $\frac{r^2}{1-m} \times \frac{V^2}{b^2} = 1$, or $\frac{r^2}{1-m} \times V^2 = b^2$,

then the equation becomes $y^2 = \frac{2r}{\sqrt{1-m}} \times x - x^2$; therefore the curve is a circle, whose radius $= \frac{r}{\sqrt{1-m}}$. But $V^2 r^{n-1} = \frac{n-1 \times c^2 r^{n-1}}{2m}$,

therefore

therefore $m = \frac{n-1 \times c^2}{2 V^2} = \frac{c^2}{V^2}$ when $n = 3$;

hence the radius of the circle $= \frac{r V}{\sqrt{V^2 - c^2}}$. In

the same manner it will appear, that the semi-transverse and conjugate axes of the hyperbola will

be $= r \times \frac{b V}{c^2 - V^2}$ and $r \times \frac{V}{\sqrt{c^2 - V^2}}$ and of

the ellipsis, $r \times \frac{b V}{c^2 - V^2}$ and $r \times \frac{V}{\sqrt{V^2 - c^2}}$; and

if the hyperbola be rectangular, its semi-

axes $= r \times \frac{V}{\sqrt{c^2 - V^2}}$.

COR. 3. If $n = 2$, the equation becomes

$$\dot{x} = \frac{b}{V \sqrt{2}} \times \frac{y^{\frac{1}{2}} \dot{y}}{\sqrt{r - 1 - m \times y}} =$$

$$\frac{b}{V \sqrt{\frac{r}{1-m} \times 2}} \times \dot{y} \sqrt{\frac{y}{\frac{r}{1-m} - y}}.$$

But $\dot{x} = \dot{y} \sqrt{\frac{y}{\frac{r}{1-m} - y}}$ is the equation of

a cycloid, the diameter of whose generating

circle $= \frac{r}{1-m} = r \times \frac{2 V^2}{2 V^2 - c^2}$; m being

=

$= \frac{c^2}{2 V^2}$. If therefore $b^2 = 2 V^2 \times \frac{1}{1-m} = 2 V^2 - c^2$, the curve will be a cycloid. Or if the value of x , in this cycloid, be taken to the corresponding value of x in the curve described, as $V \sqrt{2 \times \frac{1}{1-m}}$ to b , the curve may be easily constructed.

COR. 4. It was found above that $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = \frac{A^{n+1}}{n-1 \times y^{n-1}}$, and at the vertex of the curve $\dot{y} = 0$, therefore the correct fluent becomes $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = A^{n+1} \times \frac{d^{n-1} - y^{n-1}}{n-1 d^{n-1} y^{n-1}}$, d being the value of y when $\dot{y} = 0$. If therefore $n = 0$, then $\frac{b^2}{2} \times \frac{\dot{y}^2}{\dot{x}^2} = A \times \frac{d^{-1} - y^{-1}}{-d^{-1} \times y^{-1}}$, by reduction $\dot{x} = \frac{b}{\sqrt{2 A}} \times \frac{-\dot{y}}{\sqrt{d-y}}$; hence $x = \frac{b}{\sqrt{2 A}} \times \frac{d-y}{\frac{1}{2}} = \frac{b}{\sqrt{\frac{1}{2} A}} \times \frac{d-y}{2}$, making $x = 0$, when $y = d$. The curve therefore is a parabola, whose axis is perpendicular to the plane, latus rectum $= \frac{b^2}{\frac{1}{2} A}$ and force $= A$, measured by the velocity generated in the time (1).

NOTE.

(Referred to in page 375.)

Let $VABD$ (Fig. 8.) be a trajectory described by a body round a centre of force C , V an apse, and A the next following one; V being at a greater distance from the centre than A . It is evident, that if the body were projected from A , at right angles to CA , and with the same velocity it had when it arrived there, it would accurately describe the arch AV , and have the same velocity at V that it first begun with. For during the time of moving over any particle of the curve, the force acting upon the body, and the direction of the force are the same in both cases; hence the conclusion is clear. But if the body, instead of moving towards V , be projected in a contrary direction, at right angles to AC , and with the same velocity, an arch AB , equal and similar to AV , will be described; B being an apse, and $CB = CV$. Hence in the above equation y can have but two different values; but as these may lie in opposite directions, two may be positive, and two equal to them and negative. The other roots, if any, must either be impossible, or relate to such parts of the algebraical curve as have their concavity turned from the centre of force, or such parts as are separated from that part in which the body moves; that is, it cannot be a curve of continued curvature, as that must be in which the body moves.

The same conclusion may be deduced immediately from the nature of the equation found above for determining the

the apfides. For making the equation of limits $= 0$, we have $y = \pm P \times \sqrt{\frac{m}{m-1} \times \frac{n-3}{n-1}}$. Whence it is evident, that there can be no more than four roots, two positive and two negative. But to discover in every case the number of possible roots is a problem of considerable difficulty. *Dr. Waring* has pointed out the method of doing this (*Meditationes Algebraicæ Prob. 14.*); but as his manner of writing is in general very concise, an easy investigation of the several conclusions there deduced may not be improper in this place.

It is well known, that if by varying the coefficients of an equation two roots become equal, the next instant they will be impossible, and immediately before becoming equal they will be real and unequal.

This being granted, let it be proposed to find the number of possible roots in the equation $x^n - Ax^m - B = 0$, which is an equation of the same kind with that for determining the apfides. First, find the equation of limits, and make it

$$= 0, \text{ viz. } nx^{n-1} - mAx^{m-1} = 0, \text{ then } x = \frac{m}{n} \left| \frac{1}{n-m} \right| \times$$

$A \frac{1}{n-m}$; hence x has two values, if n and m be both even numbers, and $-A$ a negative number; wherefore the number of real roots in the given equation cannot exceed four.

Multiply the first equation by n , and the second by x , and take the difference of the products, then $\frac{m}{m-n} \times Ax^m$

$$- nB = 0; \text{ from whence } x = \frac{n}{m-n} \left| \frac{1}{m} \right| \times \frac{B}{A} \left| \frac{1}{m} \right|, \text{ which}$$

will give two other limits, if $-B$ be positive, and the rest as above.

If the given equation have two equal roots, they will coincide both with the first and second values of x just

found; therefore these values must be equal to each other; and conversely, if these values be equal, the given equation must have two equal roots; and if the conditions above mentioned take place, viz. that n , and m , be both even numbers, — A negative, and — B positive, then there will be two pairs of equal roots. Make them equal to each other, then by reduction it will easily appear

$$\text{that } \frac{\overline{m-n}^{\overline{n-m}}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m} = 0; \text{ hence,}$$

by making this expression positive, or negative, according to circumstances, the number of possible roots may be obtained.

1. If n be an even number, and — B negative, it is evident that the equation has two real roots. If n be even, and m odd, and — B affirmative, and at the same

$$\text{time } \frac{\overline{m-n}^{\overline{n-m}}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m} \text{ be negative,}$$

then there will be two positive roots; otherwise none. For the first part of the above expression is in this case negative, and the other part positive; but the first part must be greater than the second, if the roots be real; because if A vanish, all the roots are impossible; hence the conclusion is clear.

Let n , and m , be even numbers, and — A , and — B , positive quantities; it is evident that the equation can have no real roots; for in this case no quantity substituted for x can make the result $= 0$. But if — B be affirmative,

$$\text{and — } A \text{ negative, and at the same time } \frac{\overline{m-n}^{\overline{n-m}}}{n^{n-m}} \times A^n - \frac{n^m}{m^m} \times B^{n-m} \text{ be affirmative, then there will be four}$$

real roots, otherwise none. For, from what has been said above, there will be two pairs of equal roots when the
above

above expression $= 0$, wherefore by making it affirmative there will be four real roots: That the first part of the expression must be greater than the second will be evident from observing, that if $A = 0$, then all the roots will be impossible.

2. If both n and m be odd numbers, and $\frac{m-n}{n^{n-m}} \times$

$A^n - \frac{n^n}{m^m} \times B^{n-m}$ affirmative, then there will be three possible roots; otherwise only one. Because n is an odd number there must be one real root: and if the above expression $= 0$, there will be other two roots equal. But if A and B be taken such as to make it affirmative, there will be other two real roots. For $n-m$ is an even number, therefore the first part of the expression is positive; and if $A = 0$, there will be only one real root, and the above expression would in that case be negative. Therefore, &c.

If n be odd, and m even, and A , and B , have the same sign, then the equation will have only one real root; this requires no proof. But if they have different signs, and at

the same time $\frac{m-n}{n^{n-m}} \times A^n - \frac{n^n}{m^m} \times B^{n-m}$ have

a contrary sign to B , then the equation will have three real roots; otherwise but one.—If the equation have this

form, viz. $x^n + A x^m - B = 0$, then $\frac{m-n}{n^{n-m}} \times A^n$

will be positive, and it must be greater than $\frac{n^n}{m^m} \times B^{n-m}$,

for reasons given above; therefore the whole is positive.

But if it be of this form, viz. $x^n - A x^m + B = 0$, then the first part of the general expression is negative, and the second part positive, wherefore the result must be negative.

CONJECTURES *on the Use of the* ANCIENT TERRASSED
WORKS, *in the North of* ENGLAND. By JOHN
FERRIAR, M. D.

IN the northern counties of this kingdom, the sides of hills are in many places divided by regular terraces, evidently artificial. Such works are first observable in Westmoreland and Cumberland; in Northumberland they are very numerous. It is uncertain whether they exist in Scotland, for the silence of Antiquarians, who are generally bad judges of earthen works, affords no proof to the contrary. Probably, the famous parallel roads of Glenco, described in the Appendix to Mr. Pennant's Tour, are terraces of this kind, as they abound in the avenues of hilly and difficult countries. The extent of these works is very different; in some places, there are not more than three or four rows of terraces, capable altogether of containing an hundred men; but in others, the terraces mount almost to the summits of lofty hills, and would lodge a considerable body of troops. At the battle of Humbledon, the Scottish army is said to have been posted on one of these
works,

works, which is the most extensive I remember to have observed.

That such terraces were intended for military purposes, can hardly be doubted; but in what age, or with what particular view they were formed, has never yet been determined.

Mr. Wallis, in his *Antiquities of Northumberland*, supposes them to have been stations for parading the militia; but it is improbable, that in rude times, so much exertion should have been employed, in places not easily accessible, for a purpose, to which a level surface was much better adapted. On the contrary, their position, on commanding situations, secured by precipices, or difficult eminences on both flanks, or covered by advanced works of the same kind, but of smaller size, points them out as lines of defence. I believe they are chiefly to be traced on the most accessible parts of a high country, or rising from the brink of a river, to defend the passage. By what people they were raised, it is very difficult to conjecture. They differ in every particular from the British works, described by Cæsar, and are probably of more recent date, for they indicate the access of the invaders to the interior, and stronger part of the country. And no traces of the British dry walls appear in them, although stone is plentiful on the very ground where they are formed. They resemble,

ble, in some places, the Danish field-works, but their great extent, and position with respect to the sea and low country, for they chiefly point to the East and South, render it improbable that they are of Danish origin. I was once inclined to think, that they were constructed to oppose the progress of that people, because considerable terraces are visible, on the sloping eminences of some fields, near Bambrough Castle, in Northumberland, which, among a great variety of entrenchments, contain some beautiful semi-circular Redoubts, with triple ramparts.* But in a short ramble to the Lakes, in Spring, 1791, the view of ORTON SCARR, between KENDAL and APPLEBY, and of the neighbouring country, induced me to believe, that if this kind of defence were employed against the Danes, it had been, however, of earlier origin.

ORTON

* These fields deserve particular investigation. They are situated near the village of North Charleton, but distinguished neither by history nor tradition. They contain works of very different magnitude and construction, which in the whole, appear to be capable of lodging 42,000 men. In conjunction with a series of posts on the neighbouring eminences, they indicate a powerful invasion, and perhaps a succession of engagements in the plain. Whoever would examine them, (and they would amply repay attention) should begin with the circular Camp on the perpendicular rock of Spindleston, behind which the invaders seem to have landed, and proceed along the chain of rising grounds to the fields.

ORTON SCARR, (or Rock) of which I have given a very imperfect sketch from memory, lies on the north-east, directly opposite the lower opening of the pass of BREDERDALE, at the extremity of a narrow valley, watered by a small river. The front of the precipice is occupied by three rows of terraces, resembling two round bastions, connected by a curtain. On the more level part of the hill, under the beacon, some lines appear to have been drawn, but I had not leisure to trace them. Near the road, somewhat in the rear of the terraces, two small cairns are visible. The pass of BREDERDALE, which the traveller descends, in going northwards, is a steep and winding defile, commanded by precipitous hills. Where it begins to spread out towards the valley, we meet with a considerable Roman station, occupying nearly the whole breadth of the pass, from the steep bank of the rivulet, to the foot of the declivity. It appears to have been fortified with care, for it is surrounded by a lofty double rampart, and two ditches. In the bottom, where the banks of the rivulet are level, appear the traces of CASTLE HOW, which I suspect to be founded on the site of a Roman castellum, designed to protect the watering parties. It is in full view of the station. Thus we are presented with the appearance of two
G g g hostile

hostile garrisons, evidently invading and invaded. At present, all is solitariness and silence:

Stat circum alta quies, curvoque innixus aratro
Desertas fossas, et castra minantia castris
Rusticus invertit, tacita formidine lustrans
Horrorémque loci, et funestos stragibus agros.

Addison. *Pax Gulielm.*

On the opposite bank of the rivulet, lower than CASTLE How, appears to have been another Castellum. At the entrance of the defile, from the south, a few slight traces of terraces are seen, and the remains of a square entrenchment, with a shallow ditch, are discovered, adjoining, in the flat country. In temporary encampments, the Romans commonly used a ditch, from three, to five feet deep. These silent monuments impress a connected story, on the mind of the Observer, and perhaps afford some materials, for recovering a lost Chapter in History. Happily, the antiquarian vision I am about to recite, obliges us to erase nothing already recorded.

It seems, from the imperfect account of Tacitus, that Agricola was the first Roman Commander, who penetrated into that part of the country, in which these Antiquities are situated. Cerealis had reduced the Brigantes of Yorkshire, but the inhabitants of Cheshire, and Lancashire were

were unsubdued, and the people of Westmoreland had probably secured themselves, in their rocks and defiles. The incidents of Agricola's first campaign are only hinted at by Tacitus, and most of our Antiquarians have contented themselves with supposing, that he entered Yorkshire by the way of ISURIUM, or ALDBOROUGH. But the first operation of that General was to recover the Isle of MONA, or ANGLESEY, immediately before his troops went into winter quarters, and it is probable from the expressions of Tacitus, that in the following spring he proceeded northwards, along the coasts of Cheshire and Lancashire: "*loca castris ipse capere, æstuaria ac sylvas ipse prætentare - - - nulla ante Britannia nova pars illaceffita tranfierit.*"

The word *ÆSTUARIA*, can only refer to the inlets of the Western coast: the æstuaries of the MERSEY and RIBBLE, and the BAY of MORECAMB, the *Moricambe Æstuarium* of the Romans. Mr. Whitaker, in his learned history of Manchester, has therefore conjectured, with great probability, that in 79, after overcoming the Cornavii, Agricola invaded Lancashire. The appearances I have described, induce me to add to his conjecture, that the campaign was probably closed by an invasion of Westmoreland and Cumberland, and that in its course, Orton Scarr was attacked and taken. The strong country, with which the

pass of Brederdale communicates, might have been the refuge of part of the Brigantes, who had escaped from the attack made by Cerealis on the low country. From the number of British and Roman remains in this neighbourhood, it plainly appears that the hilly country was formerly well peopled, and considered as an important district. No part of it was neglected. Even the dreary pass of Borrodale received a Roman garrison. And while the religious horror of the adjoining mountains, favoured the mysterious impostures of the Druids, the beauty and convenience, of the vales and lakes, must have early attracted numerous inhabitants—The changes in the seat of population, in this island, have been so great, that in judging of the importance or remoteness of any Northern part of the country, in former times, we may almost venture to reverse its present condition. To this retreat, some of the Britons might bring an imperfect knowledge of the Roman art of war, and the invention of terraced ramparts might then be substituted for the walls of loose stones, which the first defenders of this country opposed to the efforts of the legions. Whether Agricola, after subduing the Siltuntii of Lancashire, failed up the Bay of Morecamb, or whether he proceeded along the coast, fixing a station at Lancaster, I shall

shall not undertake to enquire. It is certain, that in the route from the Bay of Morecamb to Kendal, various traces of ancient entrenchments are visible; but Dr. Stukely, by a stroke of his lively pen, has turned those scarce discernible mounds into splendid cities. Apart from this fancy of multiplying Palmyras in the desert, Dr. Stukeley was a most acute antiquarian, and an excellent judge of field-works in particular. It is therefore dangerous to question his authority, on this point.

Supposing, then, Agricola to have advanced, in his first campaign, by the pass of Brederdale, let us try how far the series of field-works described, will assist us in recovering a fragment of his history. The slight terrace-work, at the entrance of the defile from Kendal, shews that some attempt was made to resist the invading army there. The Romans had therefore encamped, as the square entrenchment indicates, hard by the pass, till the enemy retreated, or was dislodged. When the invaders reached the bottom of the defile, their camp would probably be strongly entrenched, as the post of Orton Scarr, commanding all the interjacent country, would then appear very formidable. Whether the Castella were then thrown up, to protect the watering and reconnoitring parties, or whether these were subsequent works, for the security of the station, it is impossible to determine.

The

The former conjecture is not improbable. To pass the valley, then perhaps marshy, or covered with thickets, under the eye of a vigilant enemy, expecting an attack, was an operation that might require a delay of some days, and after all, it was impossible to attack the post in front. The lines therefore must have been turned, at the accessible part of the hill, near the situation of the present high road, and perhaps the cairns point out the very place of the assault. The success of this action, would open the way to Carlisle, and to the sea. Other terraces appear on a rising ground near Penrith, facing towards Kefwick, the road from which passes through them. And on the side of a hill, fronting the river Eimont, near Brougham Castle, a considerable terraced work is very distinguishable. But no probable conjecture can be formed, respecting the other incidents of this campaign. Perhaps I have ventured sufficiently far already.

No remains of parapets are seen on any of these works, which have come under my observation, although the ramparts seem to retain their original height. If parapets were ever added to them, they would be liable to sudden decay, by the action of winds and rains, in situations so greatly exposed. At Orton Scarr, from the breadth of the platform of each rampart, it might be supposed that room was given for

Pl. V.



Februar M.D. d. l.

ORTON SCAR.

F. Muller and sculp.



for tents, or huts. But at Humbledon, and in other places, the breadth is only sufficient for a single file of soldiers. If this construction was an attempt to imitate the Roman method of fortification, the ramparts might, like those of the Romans, have been defended by projecting wooden towers, or palissades.

MISCELLANEOUS OBSERVATIONS *on* CANINE and SPONTANEOUS HYDROPHOBIA : *to which is prefixed, the HISTORY of a CASE of HYDROPHOBIA, occurring twelve Years after the BITE of a supposed MAD DOG.* By SAMUEL ARGENT BARDSLEY, M. D. M. R. M. S. EDIN. and C. M. S. LOND.

READ, OCTOBER 15, 1794.

TO add another instance of the want of success in the treatment of Hydrophobia, to the melancholy histories already published, may appear superfluous and uninstruative. Yet, when we consider the peculiar fatality of this disease—the obscurity of its proximate, and, even, sometimes of its occasional cause—and, how few opportunities are afforded of minutely attending to its preceding and attendant phenomena,

mena, there may be some reason to imagine, that every faithful description of facts will be productive of advantage; and may probably at length lead to the establishment of a just theory, and a successful mode of cure. The following case has a peculiar claim to attention, on account of the great distance of time, from the bite of a supposed rabid animal, to the appearance of the disease. It is, indeed, a difficult task, to ascertain a fact of this nature; and especially, when enquiries are to be made from ignorant and prejudiced persons. As it is, however, a matter of the utmost importance to be established, no pains have been spared, to gain every intelligence, which the Patient and his friends were capable of communicating. The result of the enquiry is in favour of the Patient's repeated assertion: "That he had
" never suffered the least injury, from any ani-
" mal; except the bite, inflicted twelve years
" since, by an apparent mad-dog."*

John

* The Patient had lived at the village of Ashworth, near Bury, from the period of the bite, till within two months of his death, when he removed to Fearn Gore, in the same neighbourhood. An enquiry was made in every family, at both places, relative to there having been any mad animal in their neighbourhood, during Lindsay's residence among them; and, if so, whether they had ever
heard,

John Lindsay, weaver at Fearn Gore near Bury, in the county of Lancaster, aged thirty-six, of middling stature, and spare habit of body, and of a temperament inclined to the melancholic, was brought into the Manchester Lunatic Hospital, on Friday May the sixteenth, 1794, about three o'clock in the afternoon. He was immediately visited by Dr. Le Saffier, who obligingly communicated to me the following particulars. The Patient expressed feelingly his sense of danger, from the persuasion that his disorder proceeded from the bite of a mad dog. He was desired to drink a little cold water, which on being presented to him he rejected, with every appearance of disgust and horror. Being again strongly urged to drink, he made the attempt, and with great exertion got down a small quantity of the liquid. He was perfectly rational, but appeared apprehensive of danger from the least noise, or approach of any person towards him. He expressed a desire to make
H h h water,

heard, or suspected, that he had been bitten, or otherwise exposed to the danger of infection. They all agreed in returning a negative answer to both these questions. I ought further to observe, that as both these villages contain few families, and these, without one exception, having dwelt in the same place, from the time of the Patient's coming among them, to the attack of his complaint, their evidence in support of the Patient's declaration, is complete and satisfactory.

water, and was quitting the room for that purpose ; but no sooner had he approached the door than he suddenly retreated, complaining of an unpleasant sensation he felt from the cold air, and particularly that it produced a convulsive twitching, about his throat. To screen him from the effects of the air, when conveyed from the examining room into the Hospital, an umbrella was held over his head, and his body closely muffled up in a wrapping cloak. As soon as he had got into his apartment, he ate some bread and cheese, but with difficulty; and requested to be allowed to drink some buttermilk. He attempted to swallow this liquid, and in part succeeded; but not without the most violent struggling efforts, attended with distortions of his countenance, which remained slightly convulsed for some time afterwards.

A consultation of the Physicians of the Hospital being called by Dr. Le Saffier, and the assistance of Dr. Percival, Physician extraordinary to the charity, requested; the latter Gentleman, in concurrence with Dr. Le Saffier, (the rest of the Faculty being out of the way) entertained not the least doubt of this Patient being afflicted with genuine Hydrophobia. As the disorder was far advanced, and might, indeed, be considered as nearly terminating, being the third day from the appearance of the symptom

tom of Hydrophobia, little or no advantage could be expected from medicine. He was ordered, however, about four o'clock the same afternoon, to take a bolus composed of twelve grains of musk, two grains of opium, and six grains of camphor. Two drachms of strong mercurial ointment were also directed to be rubbed in upon the throat and breast. I saw the Patient, in company with the other Physicians, about six o'clock the same evening; and we found him very willing, and sufficiently composed, to give a distinct account of the circumstances preceding the disease, and to describe his sufferings since its attack. The following particulars were collected. He has been industrious, sober, and regular in his mode of living; but subject to low spirits from the difficulty he found, at times, of maintaining a wife and six young children. His exertions, however, were in general proportionate to his difficulties. But of late, from the depreciation of labour, he found, that the most rigid œconomy and indefatigable industry were not sufficient to ward off, from himself and family, the calamities of hunger, debt, and the most abject poverty. The anxiety of his mind now became almost insupportable. As the last refuge for his distress, he applied, a few days previous to the attack of his complaint, to the Overseers of his Parish for their assistance to pay his rent, and thereby pre-

vent the seizure of his goods; but obtained no relief. Overwhelmed with grief and disappointment, he yielded to despair, resigning himself and family to their wretched fate. He was soon roused from this state of fancied apathy, by the piercing cries of his children demanding bread. In a paroxysm of rage and tenderness, he sat down to his loom on the Monday morning, and worked night and day, seldom quitting his seat, till early on the ensuing Wednesday morning. During this period of bodily fatigue and mental anxiety, he was entirely supported by hasty draughts of cold buttermilk, sparingly taken. Nor did he quit the loom, until his strength was completely exhausted. He then threw himself upon his bed, and slept a few hours. On waking, he complained of giddiness and confusion in his head, and a general sense of weariness over his body. He walked five miles that morning, in order to receive his wages, for the completion of his work; and, on his return, felt much fatigued, and troubled with a pain in his head. During the night, his sleep was interrupted by involuntary and deep sighs—slight twitchings in the arms—and a sense of weight and constriction at the breast. He complained of much uneasiness at the light of a candle, that was burning in the room. On evacuating his urine, he was
obliged

obliged to turn aside his head from the vessel, as he could not bear the sight of the fluid without great uneasiness. Being rather thirsty, he wished for balm tea to drink; but was unable to swallow it from a sense of pain and tightness, which he experienced about the throat, when the liquid was presented to him. He suddenly exclaimed, on perceiving this last symptom, "Good God! It is all over with me!" and immediately recalled to his Wife's recollection, the circumstance of his having been bitten,* twelve years ago, by a large dog apparently mad; which was flying from the pursuit of a number of people, on the high road between Warrington and Manchester.

During the whole of Thursday, his abhorrence of fluids increased; and he now began to feel an uneasy sensation on being exposed to the air. The slight twitchings of his arms were also increased to sudden startings; attended with a violent agitation of his whole body. He had
suffered

* Soon after this accident, he applied to a Surgeon at Ashton in this neighbourhood, who dressed the wound for a short time, and ordered the Ormskirk medicine to be taken. The wound was speedily healed; and the Patient had never distrusted his being cured, till the moment he was unable to swallow liquids. I wrote to the Surgeon, with a view of obtaining particular information relative to the state of the wound, &c.; but, the circumstance had altogether escaped his memory.

suffered much from his journey, being brought eight miles in an open cart. I perceived at this time (half past six, Friday evening) that his countenance expressed the utmost anxiety; his breathing was laborious and interrupted; and he complained of a dull pain, shooting from the arms towards the præcordia and region of the stomach. A livid paleness overspread his face; the features were much contracted; and the temples moistened with a clammy sweat. He suffered greatly from excessive thirst, and dryness of the mouth and fauces.*

An unusual flow of viscid saliva occasioned him to spit out frequently. He complained of a remarkably fetid taste in his mouth, and a loathsome smell in his nostrils. He ate some bread and butter, at his own request, but with great difficulty, as he was obliged to throw his head backward, in order to favour the descent of the morsel down the gullet. He was requested to wash down this solid food, with some liquid; and he expressed a readiness to make the trial. On receiving a basin of buttermilk, he

* We now examined the part that had been bitten, and discovered a slight *cicatrix*, almost obliterated, upon the origin of the *Tendo Achillis* of the left leg. He had never suffered any pain, nor complained of the slightest uneasiness, in that or the neighbouring parts, since the wound healed. No alteration in the colour of the skin was perceptible.

he hastily applied it, with a determined countenance, to his lips; when he was instantly seized with so severe a spasm and rigidity of the muscles of the neck, that he was compelled, in an agony, to desist from drinking. Shortly after, he raised himself upon his knees in bed, took the bowl again into his hands, and by forcibly stretching his neck forward, at the moment he received the liquid into his mouth, and then violently throwing his head backwards, he succeeded in swallowing a small portion. He appeared highly gratified with the success of this effort, and the fortitude he had exhibited; and exultingly demanded another draught of the butter-milk, as he now thought he could conquer the difficulty he had hitherto experienced. But a violent return of the spasms in the throat and neck checked this attempt. These convulsions were terminated by the stomach discharging the liquid previously swallowed, highly tinged with bile. I perceived that he had conveyed a piece of orange, under the bed cloaths, which at intervals he applied to his mouth by stealth, and as it were unperceived by himself; for he constantly hurried it to his lips, when his attention appeared to be engaged on other objects. This stratagem did not succeed. No sooner had the morsel touched his mouth, than he was seized with convulsions
about

about the throat, and a stricture at the breast. I saw him again, in consultation, at eight o'clock this evening. He had taken two doses of the bolus; and the ointment had been carefully rubbed in. He appeared rather more composed, but expressed great anxiety at the idea of being left alone. He courted eagerly the conversation of those around him; apparently from the motive of withdrawing his mind from the contemplation of his miserable state. The repugnance he felt at swallowing liquids, and the uneasiness occasioned by the attempt, he now considered as his chief complaints; and was determined to conquer the first by perseverance, and an undaunted resolution. His spasms seemed to be somewhat mitigated, as he got down a little milk-porridge with less difficulty than usual. A repetition of his medicines every three hours, was ordered during the night. At nine o'clock the next morning (Saturday) he was visited again; and we learned that he had passed the night without a moment's rest, frequently shouting out with looks of horror, and sometimes wailing in broken and confused murmurs; but, on being spoken to, he always returned rational answers. He was now alarmed to a degree of distraction, at being left alone. He examined every object with a timid and suspicious eye; and, upon the least noise of a
footstep

footstep in the gallery, he begged, in the most piteous accents, to be protected from harm. He had never offered the least violence to any one, since the commencement of the disease; and, even now, when the encreased secretion of saliva occasioned him to spit out very frequently, he apologized to the by-standers, and always desired them to move out of the way. I observed, he frequently fixed his eyes, with horror and affright, on some ideal object; and then, with a sudden and violent motion, buried his head underneath the bed-cloaths. The last time I saw him repeat this action, I was induced to enquire into the cause of his terror.—He eagerly asked, if I had not heard howlings and scratchings? On being answered in the negative, he suddenly threw himself upon his knees, extending his arms in a defensive posture, and forcibly throwing back his head and body. The muscles of the face were agitated by various spasmodic contortions;—his eye balls glared, and seemed ready to start from their sockets;—and at that moment, when crying out in an agonizing tone:—“Do you not see that black dog?” his countenance and attitude exhibited the most dreadful picture of complicated horror, distress and rage, that words can describe, or imagination paint!—The irritability of the whole system was now become excessive. He

I i i discovered

discovered the highest degree of impatience on the least motion of the air. Every action was accompanied with that hurry and inquietude, which marks an apprehension of danger from surrounding objects. The oppression of the præcordia was evidently encreased; and, when he gasped for breath, the whole body was writhed with convulsions. His speech was interrupted by convulsive sobs. The pulse was tremulous and intermitting; and, at some times, so hurried as not to be counted. He had frequent retchings, and brought up occasionally small quantities of a yellow liquid. Solids were now swallowed with excessive difficulty; and the attempt always produced strong spasms about the neck and breast. At ten o'clock (the same morning) we met in consultation; when the medicines were ordered to be repeated every two hours, with an increase of the dose of opium, from two to three grains. Half an ounce of strong mercurial ointment was ordered to be rubbed in, over the surface of the body, and a sponge dipped in vinegar to be constantly held to the mouth and nostrils. At four o'clock the same day, the consultation was renewed. We found the patient had been able to swallow his boluses without much difficulty, and had drank several times with infinitely more ease than usual; but, the fluid had been immediately rejected by the stomach, and had come
up,

up, deeply tinged with yellow. His countenance exhibited a cadaverous aspect. His voice was hoarse, indistinct, and faltering. He complained of a fixed pain at the region of the stomach; which he had felt, more or less, during the disease. The pulse was feeble, and scarcely perceptible. He swallowed some tea with less difficulty, than had been observed since his entrance into the hospital. His dissolution was apparently drawing near: yet, it was deemed advisable to order his body to be rubbed with warm oil; and one ounce of that fluid to be taken every half hour, or as often as the stomach would bear it. His mental faculties at this period suffered very little derangement; for although, when not attending to external objects, he would utter some incoherent sentences; yet, the moment he was spoken to, he was perfectly collected, and returned rational answers. At half past four o'clock, he submitted willingly to have his body rubbed with the oil, and for that purpose sat down upon the side of the bed; when he was seized with an instantaneous convulsion, threw himself backward—and expired without a groan! An immediate inspection of the body would have been a desirable circumstance: but, we were obliged, (however reluctantly) from unavoidable impediments, to defer the dissection

till the following morning. Accordingly, on Sunday morning, about ten o'clock, the body was opened in the presence of one of the physicians, myself, and two of the Surgeons belonging to the charity. I have to regret that the examination did not extend to the brain; and indeed, that a more minute investigation of the morbid appearances, accompanying this fatal malady, did not take place. But, such was the peculiar horror inspired by a view of the progress and catastrophe of the disease, that the accustomed dread of danger arising from any examination of an hydrophobic subject, was increased in this instance, to a tenfold degree. Besides, the well known prejudices entertained by the country people, against the opening of dead bodies, rendered us anxious to finish the inspection before the arrival of the patient's friends, who were hourly expected. In the cavity of the thorax no unusual appearances were discovered; except, that the surface of the lungs appeared of a darker hue, and more distended with blood than usual. No inflammation appeared on an inspection of the fauces; nor were the muscles of the Larynx or Pharynx in the least discoloured. The stomach and Œsophagus were removed from the body, and subjected to particular inspection. A longitudinal incision was made through the whole
cavity

cavity of the Œsophagus, but not the least marks of disease were discovered. Upon opening the stomach, evident traces of inflammation were observed. It commenced at the superior orifice, and was there confined to small and irregular spots of a dark red colour; and might also be traced in a linear form, and of a brighter red, along the curvature of the stomach, terminating at the pylorus in large and irregular spots of a gangrenous appearance. The contents of the stomach did not exceed three ounces; and consisted, chiefly, of the medicines that had been swallowed, mixed with a dark coloured fluid. All the other viscera of the abdomen exhibited no marks of disease.

The novelty and importance of the case above related, will, I trust, sufficiently apologize for the following enquiry. That it exhibits the genuine symptoms of *RABIES CANINA*, will not be doubted by those, who have had opportunities of seeing the malady, or have consulted the best authorities on the subject. The dread of liquids; the peculiar and distressing anxiety about the præcordia; and the morbid irritability of the nervous system, which were all experienced by this patient, leave no room for doubt concerning the resemblance of the disease to that which is the offspring of the canine poison. When we reflect on the length of the interval,
from

from the infliction of the bite of a supposed rabid animal to the appearance of this disease, an important question naturally arises:—Are we to consider this case as arising from the influence of the canine poison; or as an instance of what authors have termed spontaneous Hydrophobia? A variety of cases, related by different writers, seem to prove the existence of Hydrophobia, unconnected with the bite, or agency of the poison, of any rabid animal. The generality of systematic authors mention the occurrence of canine madness at the distance of many years from the application of the poison of a distempered animal. It has, also, been asserted, that the contact of the saliva of a mad animal with the body is capable of producing Hydrophobia. Indeed, some authors have gone so far as to maintain, that the volatile parts of the saliva, being carried off with the breath of a rabid animal, have been capable of producing the disease, when received into the stomach or lungs of any person.

I am fully sensible of the caution to be observed, in drawing positive inferences from the generality of medical histories on this subject:—For an attachment to the marvellous; a blind obedience to authority; and a rage for hypothesis seem to have possessed the ancient systematic writers, who have treated on this malady. In
order,

order, therefore, to appreciate the credit due to these various histories, and to the opinions derived from them, I shall only cite the most respectable authorities; and, indeed, chiefly confine my attention to those cases, which have been subjected to the inspection of their respective relaters. I proceed, therefore, to consider, first, the histories and facts that have been adduced in favour of the opinion, that the canine poison has lain dormant for a great length of time, and afterwards been excited into action: Secondly, those cases, which have been attributed to the contact of the saliva of a rabid animal with the surface of the skin; or to its application, internally as well as externally, by any other mode than the intervention of a bite: Thirdly, such instances of the disease, as have been said to have arisen spontaneously, * or, at least, whose origin

* I have adopted the term "Spontaneous Hydrophobia," in conformity with the usage of the generality of medical writers. But I wish it to be understood in a sense different from that, in which it is commonly used. For, notwithstanding all the usual symptoms of canine madness have arisen in many cases, without the intervention of the poison of a rabid animal, I do not conceive, in such instances, any specific poison to have been generated in the habit—The canine virus operates, not only as a stimulus on the nerves, but also appears to produce a specific action

origin could not be traced to a bite, or any other mode of infection, from a rabid animal.

I. It

action in the salivary glands, and thereby effects a change in their secretions: at least, this change takes place in the canine race.—But, there is no proof of such an assimilation of the saliva occurring in any instance of hydrophobia, arising spontaneously, or excited by any other cause than that of the poison of a mad animal. Therefore, as we know that a variety of stimulant powers are capable of producing effects analogous to those excited by the canine virus, it is more consistent with the rules of just induction, to attribute the symptoms of spontaneous hydrophobia to the operation of these powers, than to have recourse to the vague conjectural idea of their being produced by a specific poison, generated in the body. Nosologists have considered spontaneous hydrophobia, as a *species* of the *Genus* HYDROPHOBIA; but their definitions are inaccurate—It is the HYDROPHOBIA *simplex* of Dr. Cullen, and is defined: HYDROPHOBIA (*simplex*) sine rabie vel mordendi cupiditate," in contradistinction to the first species, which he describes to be: "HYDROPHOBIA (*rabiosa*) cum mordendi cupiditate, ex morfu animalis rabidi." The second species of Cullen corresponds with the HYDROPHOBIA *spontanea* of Sauvages, as his first agrees with the HYDROPHOBIA *vulgaris* of the same author. These definitions do not rest upon facts. For, so far is the "cupiditas mordendi" from being an essential symptom in the HYDROPHOBIA *rabiosa*, that it very rarely occurs in that disease—On the contrary, this symptom has taken place in several cases of the HYDROPHOBIA *simplex* or spontaneous Hydrophobia, related in the course of this enquiry; but, it by no means seems to be an essential symptom of the disease, in either species.

I. It is difficult to ascertain any precise period for the appearance of this disease, after the communication of the poison. From forty days to three months, may, perhaps, be considered, taking modern writers for our guides, as the average distance of time.—But the interval of the appearance of the disease from its supposed cause, according to some writers, is so indeterminate, as to include a period of time, from one day, * to forty years. † There are, however, several well authenticated cases, in which the disease occurred at the distance of six months, one year, and even a longer period, from the communication of the virus. In the *Act. Norimberg.* ‡ a well marked case of canine madness is described of a gardener, who was bitten September the 25th. 1720, and died, hydrophobic, on the 8th. of May, 1721.—Another indisputable case is recorded, in the same work, of a patient who fell a victim to the malady nearly a year from the date of the infection. In the *Ephemerides N. C.* § the history of a young woman, bitten by a rabid animal, is detailed; in which it appears, that the poison

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lurked

* Medical Comment. vol. V. p. 304.

† Morgagni, de Caussis et Sed, Morbor, epist. viii. art 21.

‡ Observ. 7. vol. i.

§ Ann, 7mo. obs. 148.

lurked dormant for the space of one year, and then proved fatal.

Galen * asserts from his own knowledge, that the disease in one instance did not appear till after the space of a year, from the communication of the poison. Actuarius † affords a similar proof of the disease occurring six months, and, even, one year, from the date of the bite. Dioscorides ‡ has observed, that although the disease, for the most part, discovers itself in forty days after the infection; yet, in some instances, six months and even a year have intervened. Though we may be fully warranted to conclude, from the testimony of the above authorities, to which many later examples might have been added, that the symptoms of canine madness have not been manifested till so long a period as twelve months after the infliction of the bite; yet we can place little dependance on the testimony of many authors, who have

* “Novi sane & quendam, qui, exacto anno, in eum incurfit affectum, quem Hydrophobiam vocant.”

GALEN. *lib. Prorrhet. sect. 2. com. 17.*

† “Attamen post sex menses, & anno elapso, invadere contigit, ut nos ex *experientiâ* comperimus.”

ACTUAR. *Method. Medendi. Lib. viii.*

‡ “Cum enim ut plurimum ad quadragesimum usque diem differri consueverit; neglectis tamen quibusdam, post semestre, imo etiam post annum, supervenisse observabimus.”

DIOSCORID. *Lib. vi. Cap. 3.*

have endeavoured to prove the occurrence of this disease, at the distance of five, seven, and, even twelve years, from the communication of the poison. Salius,* who ransacked all the writers of antiquity on this subject, has brought forward a variety of instances to prove the existence of these facts. But we shall find, that Salius has been contented to rely on very slender evidence, for the proof of his assertions. For instance: he quotes the authority of Dioscorides as certifying the appearance of canine madness, after an interval of seven years from the infection: yet, what does this testimony of† Dioscorides amount to? To nothing decisive: for, it goes no farther than to observe, that *some writers* have related seven years to have elapsed from the communication of the poison to the appearance of the disease. Schenkius, Zacutus, Guinerius, Platerus, &c. and, almost all the systematic writers of the 16th. and 17th. centuries have imitated the conduct of Salius. The Arabians furnished them with some authorities,

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which

* “ Hinc aliqui ad dies plures, alii ad menses, aliqui
“ anno exacto, rabie corripiuntur; in nonnullisque pro
“ ditum memoriæ ab antiquis habemus—hunc morbum
“ ad quintum, septimum, & duodecimum annum, dilatatum
“ fuisse.”

SALIUS *de affect. partic.* p. 360.

† “ Sunt, qui narrent, nonnullos post septennium, eo
“ affectu, correptos fuisse.”

Lib. vi. Cap. 8.

which may generally be traced to the Grecian writers; and these, for the most part, relied on hear-say testimony, or, the inaccurate histories of supposed cases of Rabies canina. Albertus Magnus* speaks positively, indeed, of a case, that fell under his own observation, in which the disease appeared after an interval of seven years from the bite of a rabid dog. Guenerius† has, likewise, pledged the authority of a friend; whom he esteemed worthy of credit, for the occurrence of rabies canina, eighteen years after the patient had been bitten by a mad dog. The disease proved fatal on the third day. Salmuth,‡ after quoting from various writers several instances of Hydrophobia taking place at the period of eighteen or nineteen years after the bite, relates one case, from his own authority, in which the symptoms occurred several years after the patient had been bitten by her husband, who died of Hydrophobia.—Among later writers on this subject, the same habit of indiscriminate quotation and easy credulity may be

* “Vidi hominem morsum a cane rabido in brachio, & anno septimo post incepit inflari locus cicatricis, & mortuus est infra duos dies.”

ALBERT. MAG. *de Histor. animal. Lib. xvii.*

† “Quod cuidam, post decimum octavum annum a cane rabido morso, metus aquæ accesserit.”

Tract. de Venenis.

‡ SALMUTH, *Cent. 1. obs. 96.*

be observed. Even the accurate Morgagni, * when treating on this subject, does not form an exception to the charge. He has quoted an authority from the German Ephemerides, † to support his assertion, that the canine poison has lain dormant for twenty years, and then proved fatal. On consulting the original it appears, that Morgagni either never read the case, but took it upon loose authority; or has drawn false conclusions from a statement of the facts. For the writer of this case relates, that his patient had been several days afflicted with a malignant fever; and also complained of a pain in the fauces, which were inspected by a surgeon, and found inflamed. ‡ Surely this last symptom, added to the great debility the patient laboured under, sufficiently accounts for the aversion to swallow liquids, and the consequent disgust experienced at the bare mention of them; without recurring (with the Physician) to the idle story of the patient being bitten twenty years ago, by a dog supposed to be mad. In the other instance, of § forty years intervening
between

* *Epist. Anatom. viii. Art. 21.*

† *Ephem. N. C. Ann. 9 & 10. obs. 43.*

‡ “Fauces erant siccissimæ, & tandem ob defectum

“humidi inflammabantur; malignitas indies crescebat;

“deliria accedebant, & octavo morbi die animam efflavit.”

§ *Loc. prox. cit.*

between the bite and the disease, the authority which Morgagni has borrowed is extremely suspicious and unsatisfactory. Gaspar a Reies, * to whom he has referred, after collecting at random a number of marvellous cases from different authors, closes the list with a case on the authority of Alzaharavius, in which the interval of forty years took place from the date of the infection to the appearance of the disorder. It would, therefore, appear from this enquiry into the facts brought in support of the inactivity of the canine virus for so long a period, that these writers have either been mistaken in referring the origin of the disease to a supposed far distant cause, when the actual one had escaped observation, or that they erred from too readily adopting vague and hearsay testimony.

II. With respect to the influence of the canine virus in producing hydrophobia, when applied merely to the surface of the body, I apprehend we must receive the various authorities, in favour of the fact, with some degree of caution. That the disease has occurred from the contact of the saliva of a rabid animal with the

* "Quod magis est, Alzaharavius, propria experientia, testatur, venenum per quadraginta annos in corpore delituisse."

the skin, independently of any bite, or the infliction of an apparent injury, I would not venture to deny: but that no imperceptible rasure of the skin by the teeth of the animal, or exposure of the true skin from a previous scratch—destruction of a pimple—or any accidental injury had not taken place, in most of these cases, I am rather inclined to doubt. In the German Ephemerides,* an instance is related of Hydrophobia occurring from the mere contact of the saliva of a mad animal, without the infliction of a bite.† Johan. Mathæus de Gradibus has furnished us with an instance of this disease, arising from a person applying his hand to the mouth of a mad dog. In this case, ‡ though no bite was inflicted, yet the disease manifested itself at some distance afterwards. Matthiolus advises us not to treat with neglect the instances that have been adduced by various authors, of the production of Rabies Canina, by the mere contact of the saliva with the

* Ann. 7. Ob. 121.

† “Non quidem commorsa, sed tantum saliva ex ore
“spumante hinc inde in corpore commaculata esset;
“octavo die, vehementi rabie correpta est, & tertia die
“placide obiit.”

‡ “Johan. Coqueranus infectus fuit rabie post multos
“dies, ex sola impositione manus in os canis rabidi; et si
“sum canis non memorderit.”

the naked body. He strengthens this cautionary advice, by bringing forward his own * authority to prove the occurrence of the disease, from the mere asperſion of the ſaliva on the bodies of two of his patients. Fab. Hildanus, in a letter to his friend Doctor Abel Roſcius of Lauſanne, laments the incredulity of many perſons, who had treated as fabulous the account he had given of a remarkable caſe of Hydrophobia, ariſing ſolely from a woman having applied her lips and tongue to that part of a garment which had been torn by a mad animal. In order, therefore, to baniſh the ſcruples of the moſt ſceptical, he ſubjoins a † hiſtory of the caſe, and pledges his veracity for the truth of the relation. To render this narration the more probable, he adds two caſes which fell under his inſpection, the year following the above

* “ Quippe quod duos ego viderim, qui *ſpumâ tantum*, nullo quidem ex morſu accepto vulnere, rabiem contraxerunt.”

MATTHIOL. *Comment. lib. 6.*

† “ Matronæ cuidam in via obviam canis rabioſus, qui veſtem ejus dentibus arripiens, huc et illuc trahebat; donec tandem, veſte laceratâ, *cute tamen mulieris illæſâ et intactâ*, canis auſugit: illa, vero, nescia canem rabioſum fuiſſe laceratam veſtem, *ſilo dentibus abſciſſo*, reſarcire cœpit.—Tribus menſibus poſt, viſionibus horribilibus et pavoribus agitari cœpit, et aquam et vinum odiſſe, et, quod pejus eſt inſtar canis latrare, dentibus domesticos arripere. &c.”

FAB. HILDAN, *cent 1. Obſ. 86.*

above mentioned event. The first is particularly deserving of attention, as it affords certain proof of the danger to be apprehended, if the slightest rasure of the skin be exposed to the action of the canine virus. It is the case of a young man, who received a scratch from a rabid cat, and that of so slight a kind as scarcely to raise the Epidermis. * This accident happened the summer preceding that in which the disease occurred.—He died on the third day of the attack, under all the genuine symptoms of hydrophobia. It is probable in the present instance, that the claw of the animal was the medium by which the saliva was communicated to the injured cuticle. If this were the fact, how inconceivably virulent must be the action of this poison, when so small a portion as could be conveyed by such an instrument as the claw of a cat, was capable of producing the malady!—The second case referred to by Hildanus, arose from the slightest bite imaginable of a rabid animal. This accident proved fatal to the sufferer. The well-known history which †Cælius Aurelianus relates (founded on report only) of a woman suffering the baneful effects of the canine poison, from merely applying her tongue and lips to the infected threads of a garment,

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which

* *Obs.* 86.† *De morb. acut.* lib. 3. cap. 9.

which had been torn by a mad dog, might justly have been considered unworthy of credit, had not the case of Hildanus, and a similar one mentioned by Doctor Hamilton,* served to corroborate the testimony of this author. Cardan has also recorded the circumstance of his being called in to assist at a consultation, in a case of Hydrophobia; and, on an enquiry being made into the cause of the malady, the by-standers confessed, that the patient had kissed a rabid dog, previous to its being hanged.† The patient died the following day, according to the prognostic of his Physicians. These instances are corroborated by the following case. It was communicated to me by Dr. Percival, and is supported by his own respectable authority. A man residing at Worrall in Cheshire, during his being asleep and lying on the ground, was licked about the mouth by an infected dog; but suffered *no bite*, nor the *slightest apparent injury* of the skin. He was, however, seized about the usual period with symptoms of Hydrophobia; and died of the disease, notwithstanding the usual preventive means had been adopted previous

* HAMILTON "*On Hydrophobia*," p. 22.

† "Adstantes confessi osculasse rabidum canem antequam emitteret suffocandum:—Mortuus autem est sequente die, ut nos prædixeramus."

CARDAN, *Contradiç. 9, Tract. 5. lib. 2.*

vious to its attack. Aretæus* affirms, that the breath of a mad animal being taken into the lungs of any person by inspiration, will produce the disease. This may be considered, however, as a bare assertion, unsupported by any demonstration. Palmerius† has related the history of a whole family, who were infected from kissing their father, in compliance with his request, when just expiring of canine madness. §

III.

* “Quinetiam et a rabido cane, qui in faciem dum spiritus adducitur tantummodo inspiraverit, et nullo pacto momorderit, in rabiem homo agitur.”

De causis et signis Morbor. Lib. i.

† *De Morbis contagiōsis. p. 266.*

§ I conceive this extraordinary history (and one related by Salmuth) deserving of little credit. Palmerius and Salmuth are the only writers (that I am acquainted with) who have stated, *from their own knowledge*, that a bite from any person afflicted with canine madness, has been capable of communicating that disease to any of the human species:—An abundance of negative facts might be brought to contradict this statement. But, as no absolute conclusion can be derived from them, I would suggest the following reasons for rejecting the testimony of the above-mentioned writers. First—If the saliva of an infected human-being were capable of producing canine madness in another of the same species, surely many instances of this kind must have occurred to the numerous writers on this subject; especially, when the chance of persons being exposed to the danger of such an accident is so great, that, from *two* cases only, which I have seen, *four* people were subjected

III. I come now to the consideration of the instances of spontaneous Hydrophobia. Its occasional causes are various; fright—sudden and violent affections of the mind—wounds received from enraged animals—the drinking of cold water, when the body has been previously heated—excessive fatigue in hot weather—have all been assigned by different writers, as the occasional causes of this complaint. Indeed, in some instances, it has been difficult, if not impossible, to trace its origin to any occasional cause. The following cases, carefully selected from a variety of more equivocal authority, will prove the efficiency of the above mentioned occasional causes in producing this disease; and also demonstrate, that it has sometimes occurred where no occasional cause has apparently preceded. The five cases recorded by Marcellus Donatus, and considered, by Morgagni,* as affording,

to the danger of receiving the infection: two of them, by kissing the patient, and the rest, by having had the saliva in contact with fresh wounds in their hands. Yet they all escaped without using any preventive means. Secondly; Dr. Vaughan has failed in his experiment of returning the disease from the human species to the dog. He inoculated that animal with the saliva of a rabid person, but without producing any effect. Thirdly, Salmuth and Palmerius are both fond of the marvellous; and their writings seem better calculated to excite surprize, than to convey information.

* *Epistol. Anatom.* 8. art. 31, 32.

affording certain proof of the existence of spontaneous Hydrophobia, are particularly intitled to attention. Unquestionably, Morgagni was little scrupulous in misleading his readers, when he brought forward *all* these cases, as *equally* demonstrative of the existence of this malady. If he had examined them with his usual accuracy, he would have found no room to censure the scepticism of those, who differed with him in considering *them all* as undoubted instances of Spontaneous Hydrophobia. For, notwithstanding we might give credit to the relation of Donatus, so far as respects the absolute freedom from suspicion, in all these cases, of any infection having been communicated by a rabid animal; yet it does not follow that they ought to be considered as cases of Hydrophobia, unless their symptoms warrant such an inference. In the first case,* the complaint appears to have arisen either from a laceration, or spasm of the Œsophagus; or a Paralysis of the muscles of the Pharynx. The patient was seized suddenly at dinner, with a violent pain and constriction in and about the throat, which he attempted to remove by drinking some liquor, but found himself unable to swallow it. He remained incapable either of eating or drinking till the next day, when he swallowed some grapes, but
would

* MARCELL. DONAT. *lib.* 6. p. 96 et 294.

would not be persuaded to attempt to get down any liquid. He died the same evening.

2d. A woman was seized with a pain in her arm, attended with a violent tremor of the whole body. On the third day the pain ceased, but the trembling continued. She experienced a sense of suffocation about the breast. If wine, water, or broth were presented to her, she fell into convulsions, and even faintings. She was able to swallow solids with perfect ease. The faculties of sense and reason remained unimpaired.* Her disposition was mild, and her conversation tranquil. She expired on the fifth day of the disease.

3d. A young woman was alarmed at seeing a combat with swords: she had all the violent symptoms of Hysteria, with the dread of liquids superadded. Indeed, the shock appears to have been so violent, as greatly to injure the sensorium; for she was highly delirious, intractable, and feverish. She died on the fifth day of the disease.

4th. A husbandman, 27 years of age, after his usual labour of the day, complained of a pain in his arm. On the eighth day of this complaint,

* "Si vinum, aqua aut jusculum propinetur, convellitur
"et deficit: ova ac panem probe sumat: facultates prin-
"cipes ac sentientes valde constant," &c.

MARCEL, DONAT. *lib. vi.*

complaint, he was seized with slight shiverings. He retired to rest on that evening, without having any inclination to eat. The family were alarmed in the night by his frequently uttering loud shouts, and at times requesting he might be restrained from injuring any one. His respiration was laborious and interrupted. Donatus being called in to his assistance, privately prognosticated, that the patient would refuse to drink; and if he attempted it, would not succeed; and also that his death was approaching. These events succeeded each other according to the prediction of the Physician; and the patient died in the space of four hours.

5th. A healthy and robust countryman, was attacked suddenly with sweatings and a constriction, attended with anxiety about the precordia.* The instant Marcellus Donatus saw the patient, he predicted, that he would neither swallow liquids, nor live many hours. The prognostic was speedily verified: for, when cold water was offered to the patient, he was seized with a sudden horror and fainting. The water being removed he presently recovered.† He would by no means suffer any one
to

* "*Cum angustia cordis et agonia.*"

† "*Namque ægrotanti oblatam frigidam aquam, ipse
"repentè horrescit, et linquitur animo; cā reductā, astu-
"tūm reviviscit."*

to approach him; nor could he bear, without great emotion, the sweat to be rubbed from his face. If by accident the napkin fell upon his face, or pressed lightly upon it, he seemed extremely afflicted and irritated. He expired in a few hours. Marcellus Donatus affirms, that in all these cases the strictest enquiry was made, both from the sufferers and their friends, relative to the patients having ever been exposed to the influence of the canine poison; and that they assured him there was not the slightest suspicion of a circumstance of that kind ever having happened to any of them. Morgagni * cites the authority of Kochlerus for two cases of Hydrophobia, in which the disease arose from the patients drinking cold water when violently heated. In the *Journal de Medecine*, † there are two instances recorded of Hydrophobia arising from excessive fatigue, by a long march in hot weather. Gui. Patin ‡ has also noticed the occurrence of this disease from similar causes. The German *Ephemerides* § contain a singular case of Hydrophobia from the bite of an enraged dog. The case is related by the physician who attended the patient. Jacob Otten, having chastised a
dog

* *Epist. prius cit. Art. 31.*

† *Tom. 7. Juillet. An. 1757. p. 3 & suiv. Tom. 8. Août. p. 81, p. 1757.*

‡ *Tom. 1. p. 275. Tom. 3, 169.*

§ *Ephem. N. C. An. 6. Ob. 9. p. 187.*

dog which had devoured a favourite hen, was bitten by the animal in the wrist. He was visited by his physician on the following morning. The patient complained of great stricture and anxiety about the breast; his countenance appeared stern and distressed; the tongue and throat were dry and parched, but not the slightest inflammation was visible in those parts. Although at first he was able to bear the sight of liquids, he now shuddered at them with extreme aversion. He declared some time after when pressed to drink, that he was not able, without feeling the most excruciating torments, to look upon, much less to swallow liquids. The wound had healed during the time he suffered these complaints. He died about the sixth day of the disease. The dog was not mad, as he was alive and well long after the patient died. Another case described in the same work,* by Doctor J. B. Scarra-muchi, claims a particular attention, on account of the symptoms being so strongly marked. A young man, in a paroxysm of rage from some domestic troubles, bit the index finger of his left hand, at about eight o'clock in the evening. On the next day at four o'clock, P. M. he was seized with slight shiverings, accompanied with a vomiting of bile. At this period he experienced

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* An. 9. in Append. p. 249.

rienced a dread of water,* and every other kind of liquid—nor was he able to bear the sight of polished and strongly illuminated objects. To such a degree was the abhorrence of water felt, as to occasion a sense of suffocation at the bare mention of it. He afterwards became delirious, spitted upon the by-standers, and was with difficulty restrained by violent coercion from injuring them. He vomited large quantities of bile, and a dark coloured fluid. His strength sunk gradually, and he expired in the space of a few hours.† Johan. Hen. Brechfeld has related the case of a gentleman, who was seized with hydrophobia in so violent a degree, as not to be able to swallow the smallest portion of any liquid. He had no difficulty in swallowing solids. On the third day of the disease he spitted at the by-standers; and suddenly expired in his chair on the next day, after an attack of one or two general convulsions. Upon a strict enquiry being made into the cause of his complaint, and particularly with respect to his having been at any time exposed to infection from

* “Versus horam 16 aquam, omnemque alium liquorem, necnon corpora lucida et candida abhorrescere incepit, ita ut etiam ad aquæ mentionem strangulari videretur.”

† Aët. Hafniens. An. 1682.

from a mad animal; he declared, when perfectly rational, that he could not recollect such an event to have happened;* nor was he able to assign any cause for the origin of his disorder. I consider the following case related by Dr. M. Lister,† as deserving particular notice. If it be not considered an instance of Hydrophobia, occurring without the agency of the canine poison, we must be compelled to grant, that the bite of a dog proved infectious when no symptoms of disease had appeared in the animal at the time the wound was inflicted, nor for six weeks afterwards. The writer of the case has not made us acquainted with the fate of his animal at any subsequent period. Now that a rabid dog should be capable of communicating the infection, previous to any symptom of the disease having discovered itself, is in direct opposition to general opinion. It is likewise equally repugnant to particular experience,‡ and to the analogy to be observed

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* “An a cane rabido demorsus unquam fuerit? A me interrogatus (cum mente adhuc constanti) se id non meminisse aiebat.”

† Tract. de morbis quibusdam chronicis. Histor. I.

‡ In order to obtain satisfactory information on this point, I wrote to Hugo Meynell, Esq. whose knowledge on the subject of the diseases of dogs must be superior to most others,

in the operation of most other infectious diseases. Besides, the length of time (above six weeks) from the bite to the death of the patient, exceeds the general period assigned for the fatal termination of madness in dogs. Doctor Hunter,* in his ingenious paper on this subject, observes, that the disease generally proves fatal to dogs *in three weeks*. Is it not then a little extraordinary, that Doctor M. Lister should have expressed no doubts, relative to the power this dog had of communicating the infection, when he confesses the animal appeared free from any symptom of madness, at the time the patient

others, from his long experience and attention to whatsoever regards their health and safety. He obligingly returned the following answers, to some queries I had proposed. — 1st. "Madness generally appears between a month and six weeks after the bite; about a fortnight is the shortest, and eight months the longest period I have known it to appear in after the bite." 2d. "I know no instance of a dog apparently in good health having communicated the disease; but I have known the disease to have been communicated by a dog that, to one who was not a nice observer, or was not well acquainted from experience with the symptoms of canine madness, might have appeared in perfect health." 3d. "I am not acquainted with any instance of a dog having apparently recovered, and then relapsed, after the symptoms of the disease had once appeared."

* See Transactions of a Society for the improvement of medical knowledge, vol. i. p. 295.

patient died? * I shall quote such passages, from the history of this case, as will certify, beyond dispute, the identity of the symptoms with those usually exhibited in canine madness. A young man was slightly bitten in the arm by his own dog. The animal returned quietly home with him on the same evening. The wound was suffered to heal spontaneously. About forty days after the accident happened, the patient was seized with flying pains over his whole body; but especially about the region of the præcordia. On the day following he was troubled with a constant inclination to vomit, attended with violent twitchings at the stomach. With great difficulty he was able to swallow his saliva. He refused to drink some water which Doctor Lister presented to him. His countenance now exhibited great distress. He was able to swallow solid food when presented in a spoon. On the fourth day these symptoms had increased to the highest degree: To swallow his spittle now became so dreadfully difficult, as to threaten instant suffocation. The sight of water was terrible. Every object inspired him with dread. His mind was,

however,

* “*Neque illud silentio prætereundum est, ipsum canem a quo morsus est, hominem eâ nocte secutum esse; imo ipse canis vivus et sanus esse videbatur, quo tempore homo mortuus est.*”

however, sufficiently composed to frame his will ; and he inspected his book of accounts. He had no suspicion of the nature of his complaint until Doctor Lister made some enquiries. On the same evening he expired strongly convulsed, immediately after making an effort to swallow some beer.

The frequent occurrence of an aversion to fluids, and of great difficulty in swallowing them in women affected with Hysteria, has been noticed by many writers.* Some of these facts demonstrate, that all the symptoms of canine madness have been brought on by violent affections of the mind, in irritable and delicate habits. The fatal termination of some of these instances, tends further to confirm the strictness of the analogy between canine madness and hysteria. Platerus† takes notice of a singular instance of hydrophobia in consequence of terror. A woman, of an irritable state of nerves, was much alarmed at being left alone by her companions on the banks of a river, where she had been employed in washing linen. As the evening approached, her fears increased. After returning home she was seized with a violent sobbing, and was almost in danger of suffocation. These symptoms increased daily ;

* MORGAGNI, MEAD, SCHENKIUS, PLATERUS, &c.

† *Observ. Med.* PLATER, *Lib.* 1.

daily; and an utter aversion to fluids supervened. The motion of the air, and the appearance of luminous objects, were equally offensive. She expired under the pressure of these symptoms on the eighth day of the disease. Sauvages * has recorded a fatal example of hydrophobia in a young woman, in consequence of the mind being violently agitated, during a morbid and irritable state of the body. In this patient, the sight of any kind of fluid produced dreadful convulsions, and it was not possible to prevail upon her to swallow any medicine. The patient died three days after the accident. A variety of cases might be cited, in proof of the strict similarity between the symptoms of Hysteria and Rabies Canina from the Ephemerides N. C. I shall content myself, however, with
having

* “Une servante ayant été vivement pressée par un jeune homme dans le temps de ses règles, cette évacuation s’arrêta, et quelques heures après, le jeune homme ayant renouvelé ses tentatives, la fille entra dans une espèce de fureur. Dès ce moment elle se plaignit de douleurs vagues par tout le corps, et ces douleurs furent suivies d’une fièvre ardente, et d’un délire si violent, qu’il fallut lier la malade. Ces accidens furent suivis de l’hydrophobie la plus décidée. A la vue de toute espèce de liquide, la malade tomboit dans des convulsions affreuses; elle rejetoit jusqu’ aux alimens solides, et il ne fut pas possible de lui faire aucun remède. Elle mourut trois jours après son accident,”

SAUVAGES, *Nosol.*

having stated the above ; and proceed to draw some inferences from the general recital of preceding facts.

I. That the poison of a rabid animal may lay dormant in some instances for the period of twelve, and even twenty months : yet that the cases related by various authors, where canine madness is said to have occurred at the distance of *seven, twenty, and forty years*, from the communication of the poison, may be justly considered as either instances of spontaneous hydrophobia, or of such diseases as occasionally exhibit the anomalous symptoms—of an inability to swallow fluids, and an aversion at the sight of them :—The poison of a mad animal has had no share in their production.

II. That the mere application of the saliva of a rabid animal to the skin, especially to those parts where its structure is of a thin and delicate texture ; such as the lips, tongue, &c. has produced the disease of canine madness ; but that the inspiration of the breath of a mad animal by any person, has ever produced this complaint appears highly improbable, and is not supported by positive facts. III. That local irritation from wounds in irritable habits, especially when conjoined with a perturbed state of the passions ; and, also violent affections of the mind, independently of corporeal injury, in hysterical and hypochondriacal constitutions, have

have produced all the pathognomonic symptoms of canine madness; and finally, that violent alternations of heat and cold, and all other causes, which induce great debility, and at the same time increase the irritability of the system, have at times proved adequate to the production of symptoms, exactly corresponding with those of Rabies Canina. Perhaps the following observations may tend to elucidate, more fully, the propriety of adopting the above inferences.

I. I conjecture that those writers who noticed the occurrence of canine madness at the distance of seven, twenty, and even forty years, from the supposed communication of the virus, have either been mistaken, in considering the anomalous symptom of an inability to swallow fluids, which is sometimes met with in fever, hysteria, and other diseases, as an effect of the animal poison; or have been ignorant that Hydrophobia has occurred in particular habits, without the possibility of assigning any specific cause for its production. Moreover, it is a fact founded on the observation of a considerable number of cases, that upon the average, not more than one* person, out of twenty-five who

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* See HAMILTON'S Treatise on Hydrophobia; DR. VAUGHAN'S "Two Cases of Canine Madness;" and DR. HUNTER'S Paper on this subject in the Transactions already quoted.

have been certainly exposed to the bite of a mad dog, has become infected with the disease. Therefore, when symptoms of Hydrophobia have appeared at the distance of many years from the bite of an animal really infected, no positive conclusion can be drawn from this circumstance; as the disease is by no means a certain consequence of the bite. II. Notwithstanding the host of negative facts which may be brought to disprove the occurrence of infection from mere contact of the saliva with the skin, yet the positive facts already quoted from good authorities are of such force, as to stamp conviction on the mind, of the possible, though rare occurrence of canine madness from this cause. If this conclusion be just, may we not imagine in some cases, where the poison is said to have manifested itself after a very long interval from the bite of a rabid animal; and, indeed also in some of those cases which have been considered altogether as spontaneous, that the poisoned saliva may have been *recently* communicated, either indirectly, through the unsuspected medium of the cloaths, or directly, by fondling* or

* It is not possible to use too strict precaution in avoiding a familiarity with strange dogs. DR. HUNTER, in the work before alluded to, has remarked, that almost all the accidents related to the society arose from taking notice of strange dogs.

or playing with an animal, not known to have been rabid? That such accidents very rarely occur, will be readily granted; yet, as they seem to be within the limits of probability, an important lesson is held forth to medical practitioners, not to neglect those cases where the saliva has been communicated merely to the skin, without any visible injury being sustained. III. The histories of Hydrophobia, related by different Authors, as arising from local irritation of wounds, or from violent affections of the mind, operating suddenly and powerfully on the nervous system, merit a due consideration. The credibility of these histories seems not only to be confirmed, but also the strict analogy between their symptoms and those of canine madness to be farther illustrated, by the occurrence of Hydrophobia in some cases of Tetanus. Facts of this kind have been observed, and commented upon, by two celebrated Physicians.* Doctor Rush† has remarked the joint similarity of some species of Tetanus, with Hydrophobia. Having particularly noticed the symptoms of irritability and debility—and the sense of strangulation felt on swallowing liquids—as occurring in both maladies, he justly inferred, that these diseases were nearly related in their proximate cause of ner-

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* DR. PERCIVAL and DR. RUSH.

† Essay on Tetanus—Medical Inquiries, v. 1.

vous irritation, and therefore required the same mode of cure. With equal sagacity, and by a striking coincidence frequently to be met with among men of talents and observation, Doctor Percival* had pointed out the same resemblance between these diseases, and had also suggested a similar mode of cure, previous to the publication of Dr. Rush on this subject. Both these Authors have produced several cases to confirm their opinions. The following striking instance of similitude between Tetanus and Hydrophobia was communicated to me by Dr. Percival. The case occurred since the publication of his valuable observations on canine madness, and was sent to him through the medium of Doctor Haygarth. Mr. Wilmer of Coventry, well known by his many ingenious works, attended the patient, and furnished the description of the case. — “ A young gentleman, pupil to a Surgeon of this town, had the middle finger
“ slightly wounded by a splinter of wood, on
“ its internal edge, and just over the part where
“ a nerve accompanies the artery to the end of
“ the finger. In about a week the little wound
“ healed. A day or two after, he complained
“ of a stiffness in his throat and neck. This he
“ attributed to his having taken cold. The
“ complaint

* *Essays Med. and Experim.* vol. II.

“ complaint increased, and extended to the
“ muscles of the face and jaw. The muscles
“ which move the lips were affected with spasms.
“ A pain was felt about the scrobiculus cordis.
“ In three days the lower jaw was locked. The
“ convulsive motions of the muscles of the face
“ recurred only at intervals. He had taken, during
“ the three first days, Tincture of Opium
“ with Camphor Julep, in large quantities. On
“ the third day his lower jaw was less fixed, but
“ he could take no more of his fluid medicine;
“ and all watery drinks he found impossible
“ to swallow. Whenever they approached his
“ mouth, the convulsive spasms of the face returned,
“ and his head was forcibly drawn
“ backwards. He was now ordered opium in
“ a solid form, which was persevered in without effect.
“ Clysters of asafætida, opium, &c.
“ were repeatedly given. The nerve leading to
“ the part affected was divided transversely with
“ the knife. On the fifth day he appeared somewhat
“ better, when we were hastily called to
“ him, as he was supposed to be dying. Universal
“ convulsions, (during which the mucus
“ was plentifully collected in the corners of his
“ mouth) seized him. In the space of twenty
“ minutes the spasms ceased. Electricity was
“ proposed, and tried. After he had received
“ a few shocks, the convulsions returned, and
“ in

“ in less than ten minutes he died. Doctor
“ Simson, Mr. Cole, and Mr. Whitwell, as
“ well as myself, attended him; and we were
“ all of opinion, that if the symptoms I have
“ described had followed the bite of an ani-
“ mal, instead of the injury done to his finger
“ by a splinter of wood, we should have had
“ some difficulty in determining whether the
“ disease was Tetanus or Hydrophobia. A-
“ bout ten years since I attended a patient, whose
“ symptoms were nearly similar to those above
“ related, and which were the consequence of a
“ bite from a horse. After opium, and other
“ antispasmodics, were ineffectually tried, he
“ recovered by the use of electricity.”

If there were any necessity for additional proofs of the occurrence of Hydrophobic symptoms, in cases of local injury, a variety of instances might be brought forward, from Hildanus, Cœlius Aurelianus, Schenkus, and other writers. But the fact seems to be sufficiently established. It appears then, that the occasional causes productive of spontaneous Hydrophobia, operate either locally or generally upon the nervous system, by increasing its irritability, and at the same time inducing debility. It is also sufficiently evident, that the action of the canine poison produces similar effects. But its superior mischievous activity, in comparison with any other occasional cause,

cause, cannot be denied. Yet I apprehend we ought to attribute the more fatal virulence of the canine poison, rather to the difference in degree, than in the nature of the cause. For undoubtedly, the identity of effect warrants the conclusion of an identity of the cause. Happy would it be for the patient, as well as grateful to the practitioner, if farther practical experience in the mode of cure, should confirm the truth of the above inference!

In the *Act. Norimberg.* Tom. II. there is a case of Hydrophobia related, in which all the symptoms of canine madness were combined with Hysteria. A cure was effected by the exhibition of tonic and antispasmodic medicines. Doctor Nugent's extraordinary case of Hydrophobia affords a similar proof of the efficacy of these remedies.

In both these instances, the symptoms appeared altogether in as violent a degree as in any case of canine madness. We may then rationally expect, that application and perseverance will at length discover a remedy sufficiently powerful to counteract the virulent effects of the canine poison.

From a review of the whole of the preceding facts and observations, are we to consider the unhappy case prefixed to this enquiry, as arising from the bite of a rabid animal, inflicted twelve
years

years since; or may we, with more probability, attribute the disorder to some unobserved or forgotten communication of the canine poison with the skin; or, finally, must we not be compelled to view this case as a genuine instance of spontaneous Hydrophobia? It is with diffidence that I incline to the last opinion. But when I reflect that we have no authentic testimony of the canine poison lying dormant more than twenty months at farthest; that Hydrophobia, with all the pathognomonic symptoms of Rabies Canina, has been produced by other occasional causes than the infection of a rabid animal; and also that notwithstanding a person should have been really exposed to the canine poison, the chances are greatly in favour of his not being infected—I am compelled to conclude, that this patient fell a victim to other causes, than the poison of any rabid animal. Nor do I conceive that the effects detailed in this case are disproportionate to the power of the supposed causes. We ought to consider the melancholic temperament of this patient, so much predisposed to mental and corporeal irritation—the weight of his affliction at the heart-rending prospect of his family's distress—his unremitted, but ineffectual efforts to remove these calamities—and the scanty portion of sustenance he allotted to himself, during this almost unexampled struggle of strenuous

strenuous exertion, against famine, debt, and despair! Add, to these circumstances, the effects of imagination in aggravating the violence of the disease. For, although the patient's dread of liquids did not arise from this cause, as he felt a difficulty in swallowing them previous to being impressed with a remembrance of his having been bitten by a supposed mad dog, yet the moment this idea took possession of his mind, he considered his recovery as hopeless. The image of the dog haunted his imagination with perpetual terrors; and the expectation of a violent death, by being smothered, (a vulgar and unjust persuasion too often entertained) would not a little tend to increase the nervous irritation already excited. I have before mentioned, that this case, from the disease being in a very advanced stage, was considered as irremediable. Nevertheless, such remedies were administered as are usually recommended in the cure of this complaint. Among these the external and internal use of oil were tried; but indeed, at so late a period, as not to afford any great expectation of relief being obtained. It may not be improper to mention here an idea that occurred to me on reading the two cases related by Doctor Shadwell,* in which he trusted solely to the exhibition of this remedy. In one instance it

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* *Memoirs of the London Medical Society*—last vol.

proved successful, but failed in the other. Dr. Shadwell attributes its failure in the case of the boy, to the difficulty he experienced in swallowing it, joined to an extreme repugnance to make the attempt; so that only a very small portion (in comparison with what the man took) could be forced down. As this difficulty of swallowing fluids, and consequent aversion to them, arises from the morbid irritability of the fauces, and muscles subservient to deglutition, I conceive, that the impediment to the use of oil, (as well as other fluids,) might be overcome, by adopting the same mode of administering it, as was practised by the late Mr. John Hunter,* to convey food into the stomach of a patient, who

* "The instrument made use of was a fresh eel skin of rather a small size, drawn over a probang, and tied up at the end where it covered the sponge, and tied again close to the sponge where it is fastened to the whale bone, and a small longitudinal slit was made into it just above this upper ligature. To the other end of the eel skin was fixed a bladder and wooden pipe, similar to what is used in giving a glyster, only the pipe large enough to let the end of the probang pass into the bladder without filling up the passage. The probang thus covered was introduced into the stomach, and the food and medicines were put into the bladder, and squeezed down through the eel skin. But as cases of the kind may occur where eels cannot be procured, a portion of the gut of any small animal, as a cat or a lamb, will make a very good substitute." History of a case of Paralysis, &c. in the Transactions already quoted;

who was afflicted with a Paralysis of the Œsophagus, and consequently was unable to swallow any nutriment. By this mode the oil could not come in contact with the irritable parts of the gullet, but would immediately enter into the stomach, and thereby afford to the patient that chance of relief which the remedy has been said to have effected, at least in one instance. It is well known that the Antients relied greatly upon the use of this remedy. Cælius Aurelianus,* among other antient writers, recommends its use; but was aware that in most cases it could not be swallowed, and therefore orders its exhibition by another mode.

Since I entered on the discussion of this part of my subject, I have read with great satisfaction an account,† by J. Williams, Esq. of the surprising efficacy of a remedy against the deleterious effects of the bite of several snakes; and especially of the Cobra de Capello. These facts are not only interesting, as pointing out a certain and simple mode of rescuing those exposed to the bite of these venomous reptiles, from almost inevitable death, but also highly deserv-

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* "Quod ita facere poterimus, si calidam atque oleum clystere per podicem injiciamus; et si fieri poterit, diurnis diebus, parvum quidem tunc enim poterit contineri."

CÆL. AUREL. *lib.* 3, 231, *de morb. acut.*

† *Asiatick Researches*, vol. II. p. 323.

ing attention, as they demonstrate an analogy between the symptoms arising from the poison of some snakes, and those produced by the bite of a rabid dog. And surely, in the treatment of so fatal a disease as canine madness, it is proper to adopt any method of cure founded upon rational principles. Analogy, under these circumstances, seems to be our surest guide.

The author of this discovery has detailed several cases, selected from a variety of others, which terminated with equal success. His method of cure entirely consists in the external application to the bitten part, and internal exhibition, of the spirit of the caustic volatile alkali.* *Eau de Luce* (which is generally at hand) answers as well; but he, with reason, prefers the pure caustic Alkali, when it can be readily met with. This remedy has uniformly put a sudden stop to the baneful effects of the poison of the *Cobra de Capello*.

The action of this poison seems to be chiefly confined to the nervous system, and resembles that of the canine virus, in exciting convulsive spasms about the throat and fauces,† difficulty
in

* The "*Aqua ammoniac puræ*" of the College Dispensatory.

† Case 2d. p. 325.

"In July 1782, a woman of the Brahmen cast, who liv in my neighbourhood at *Chumar*, was bitten by a

In swallowing, and a flow of saliva from the mouth. Whether the remedy acts specifically, by destroying the quality of the poison, or generally, by stimulating the nervous system, cannot with certainty be determined. But I am inclined to adopt the latter opinion. At all events it is abundantly proved, that the effects of a most deadly poison (which acts violently on the nerves) have been counteracted by the operation of a certain medicine. There is, therefore, sufficient reason to hope, that its exhibition in canine madness may be attended with salutary effects. For, if two distinct kinds of poison, generated by different creatures, produce similar phænomena in the human constitution, we may fairly conclude that these effects originate from the same proximate cause. There will certainly be great, if not insuperable

“Cobra de Capello, between the thumb and fore-finger of
“her right hand: prayers and superstitious incantations
“were practised by the Brahmens about her till she became
“speechless and convulsed, with locked jaws, and a profuse
“discharge of saliva running from her mouth. On
“being informed of the accident, I immediately sent a
“servant with a bottle of volatile caustic alkali spirit, of
“which he poured about a teaspoonful, mixed with water,
“down her throat, and applied some of it to the part
“bitten. The dose was repeated a few minutes after, when
“she was evidently better, and in about half an hour was
“perfectly recovered.”

able difficulty, in administering caustic volatile Alkali Spirit (necessarily diluted with a portion of some mild and insipid liquor) in Hydrophobic cases, where the increased sensibility of the fauces to irritation, and the dread of liquids, are so strongly felt. Perhaps it would be advisable, in such cases, to mix the volatile alkali with crumbs of bread, and form the mass into bolusses; or rather, to exhibit the caustic volatile salt enveloped in wafer paper. By this latter method the pungency of the medicine would be concealed, and its form might enable the Patient to swallow it with greater facility.

Before I conclude this subject, I cannot avoid hinting at the necessity of adopting some general plan, for preventing the communication of the canine virus by infected dogs, to animals of the same species. The great increase* of mad dogs, and the consequent ravages of canine madness among the human species, during the course of the present year, (1794) demand the serious and speedy attention of the Legislature. For I conceive Government alone to be capable of establishing a plan of prevention on so extended a scale, as may afford a rational prospect of totally eradicating this dreadful malady. Nor

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* No less than forty persons applied to the Infirmary at Manchester, in the course of a fortnight, who had been bitten by dogs undoubtedly mad.

is the project so hopeless as might, on a slight consideration, be imagined. If the fact be sufficiently established, which Mr. Meynell has asserted from experience—That he preserved his Kennel from canine madness for a series of years, by making every new hound perform quarantine for a certain time, previous to his admission among the pack,* it forms a strong presumption that the disease is *ALWAYS* produced by an actual communication of the poison of an infected animal. This conclusion is farther strengthened by the well-attested fact, mentioned by Dr. Hunter, and other writers,† of canine madness not having been known to exist in the Island of Jamaica, for the space of forty years. The distance of this island from the Continent is the probable cause of its freedom from the complaint. For, if the canine poison discovers itself in dogs within three weeks or a month, its importation into the island would be prevented by the death of the infected animal during the voyage. As it appears then highly probable, that canine madness can only be produced by an actual communication of the poison of an infected animal, would not an Act of the Legislature, ordering all dogs to be carefully confined for a certain time (six weeks would probably be sufficient)

* See Dr. Hunter's paper in the "Transactions," &c.

† Consult Dr. Mosely's Treatise on the diseases of tropical Climates, &c.

sufficient) prove adequate to the prevention of the disease, without having recourse to the so frequently suggested, but certainly cruel and nugatory method, of destroying, (or rather of taxing so as to cause to be destroyed) the majority of dogs in the kingdom?

*Farther EXPERIMENTS and OBSERVATIONS on the
VEGETATION of SEEDS. By Mr. JOHN GOUGH.
Communicated by Dr. HOLME.*

READ, DECEMBER 12, 1794.

IT was remarked, in the concluding paragraph of my former paper on this subject, that seeds, soaked in water and confined in small quantities of air, do not always lose the faculty of vegetating. At the same time it was hinted, that this difference arises from the changes, which are constantly taking place in the temperature

perature of the atmosphere, and consequently in all bodies surrounded by it. I shall now endeavour to prove experimentally the truth of what I formerly advanced as a probable conjecture, by shewing that the vegetative principle in seeds is destroyed by the putrefactive fermentation; and that the commencement of this process depends on the changes in question being accelerated or retarded, as the temperature increases or diminishes.

EXPERIMENT X. Jan. 31st. 1794. — Three ounces of dry peas were put to soak in rain water: February 2d. four drams of the peas, which had now been steeped forty-eight hours, were removed into a phial, which was then filled with water, and inverted in an earthen jar of the same: that part of the bottle which was out of the vessel being screened from the light by a case of brown paper. It was then placed, in a window looking to the North, (where a thermometer was hanging) close to the vessel containing the water, in which the remaining part of the three ounces was immersed.

At the same time, I placed two drams of the peas, thus soaked, in a phial; and removed them to a much warmer room, where they soon vegetated. The same was repeated, with equal success, at the end of every forty-eight hours, to the eighth.

In the mean time the thermometer was be-

tween 38° and 48° , being commonly at 43° . The bottle remained full of water to the sixth; but the weather then became warmer (the thermometer standing at 46° or 48°), and two large bubbles of air were seen in the upper part of the glass on the eighth. These bubbles were somewhat larger on the tenth; and nearly two dram-measures of air occupied the higher part of the inverted phial on the twelfth.

The usual quantity of peas, viz. two drams, placed in a dry bottle, on the evening of the tenth, shewed hardly any signs of vegetation on the 13th. (thermometer from 46° to 48°) : but, on the 15th. six, out of seventeen, had produced sprouts. An equal quantity of the peas which were yet lying in the water, was treated in the same manner on the 12th; but they shewed no signs of vegetating on the 17th. This is a proof that the peas yet in water had been spoiled by putrefaction; the commencement of which was certainly indicated by the air extricated from those in the inverted bottle. The gas that was collected by the bottle, in the course of the experiment, consisted principally of *carbonated hydrogene* mixed with nearly one quarter of its bulk of *carbonic acid gas*.

One circumstance seems worthy of notice, though not strictly applicable to the subject of the present enquiry. The peas appeared to be
saturated

faturated with water at the end of two days; at least I judged it to be the case from the following circumstances: seventeen of them weighed two drams on the second of February; and the same number came within a very few grains of the same weight, over or under, to the end of the experiment. Thus it seems clear, that it is a matter of indifference, whether soaked seeds be separated from the air, by the interposition of *water* or *azote*; because it is almost certain, from the preceding remark, that the former fluid has no power to change the nature of them, after they are fully charged with it. It is evident from this experiment, that the putrefactive fermentation, or an emission of *gas*, from their substance, destroys the vegetative faculty of peas; from which we may venture to conclude, that it has, sooner or later, the same effect on all other seeds exposed to its influence.

This experiment being made in cold weather, the destructive process proceeded but slowly, and the peas used were long in losing the power of producing. In order therefore to determine how far an increase of temperature would accelerate the commencement of putrefaction, I repeated it twice during the warmer months of summer, in a room where the thermometer varied from 60°. to 66°. In the former of these

trials, a very strong fermentation took place before forty-eight hours were expired; and when a part of the peas thus treated was exposed to the air, at the end of two days, none of them sprouted.—In the second, they were not so soon injured; for a few of those which were tried on the third day vegetated. Thus it appears, that an increase of temperature proves injurious to seeds secluded from the air, by promoting putrefaction in them, and thereby destroying their vegetative power.

EXPERIMENT XI. Seeds properly moistened emit *carbonated hydrogen* mixed with *carbonic acid*, when surrounded with *azote*, as freely as others of the same kind do when immersed in water; for if wet peas or barley be confined in a known quantity of *azote*, as in EXPERIMENT IX. the volume of gas will remain the same for a few days, but will begin to increase more or less rapidly at the end of an indeterminate time; which is longer when the temperature is lower, and the contrary. Hence it is evident, that a portion of fresh gas is afforded by the materials inclosed with that contained in the jar; and thus is the bulk of the given quantity enlarged. Moreover, if a bottle charged as in EXPERIMENT VIII. be left closely stopped, for twelve or fourteen days, in a moderate temperature, the common air contained in it

will

will be first rarefied, as we have proved before ; but its density will in a short time begin to increase again from the gas emitted by the wet grain, as will appear if the inverted bottle be opened under water : for, upon removing the stopper, a quantity of elastic inflammable fluid will rush from the neck immediately, which will be succeeded by a discharge of bubbles of the same kind. Hence it appears, that the putrefactive fermentation destroys the vegetative power of seeds surrounded by *azote* or covered by water : consequently the presence of *oxygene* is necessary for preventing this destructive process ; which it does by producing another, that may be called the *vegetative* fermentation.

The reason why one of the two kinds of fermentation in question always takes place, in seeds prepared by soaking, seems to be this : the water, thus introduced into their composition, changes that proportion of their component parts, which is required to preserve them in a sound state. If they be then exposed to the atmosphere, the action of its *oxygene* awakes the faculty of vegetation in them. On the contrary, when they are surrounded by *azote* or water, which do not appear to act on them, the component particles in their texture are left to form new combinations among themselves, and are partly converted into *gas* ; the appearance of which indicates the commencement of that stage
of

of putrefaction, by which the faculty of vegetating in the atmosphere is destroyed. We may now venture to explain, on rational grounds, a curious circumstance alluded to in my former Paper, (page 310): I mean a property, which the seeds of particular plants possess, of continuing sound and uninjured in the ground for many years, provided it remains fallow; but which vegetate vigorously as soon as the soil is pulverized by the plough. For it has been shewn, that an increase of heat accelerates the putrefaction of seeds charged with water and deprived of air; from which it may be safely inferred, that the preservation of these bodies may be infinitely prolonged, by excluding them from the atmosphere, in a situation where the temperature never exceeds a certain degree, which is not the same for all seeds, but depends on their respective properties. Thus, for example, though peas immersed in water lose the faculty of producing in ten or twelve days, when the thermometer is between 40° and 50° , and much sooner in warmer weather, we are not to conclude that all other seeds are as quickly rendered useless in similar circumstances. For I repeated the tenth experiment in July, with several kinds, in a room where the thermometer was commonly higher than 62° ; when it appeared that Barley began to putrify on the fourth day;

Wheat

Wheat on the sixth; white Mustard-seed on the eleventh; but Beans, treated in the same manner, continued sound and vegetated at the end of three weeks. Hence no one has a right to affirm, without actually making the experiment, that the seeds of Broom, Cockle, and many more plants that might be enumerated, would be soon deprived of the vegetative principle. On the contrary, we may venture to assert, that, if such seeds will not putrify with the summer temperature of the ground, at the depth of five or six inches, when placed out of the reach of the air, they will immediately vegetate upon being again exposed to its influence. This is at least a plausible explanation of the phenomenon in question. But in order to put it to the test of experiment, I took some seeds of Broom, which had been soaked for three days in water, on the fifteenth of August; and, after mixing them with moist sand, filled a small phial with the mixture. The phial, being well corked and wrapped in paper, was kept to the thirteenth of September, in a room where the thermometer was commonly at 65° and sometimes rose to 70° . These seeds, being planted afterwards in a pot filled with earth, vegetated.

EXPERIMENT XII. On the nineteenth of January, I put a quantity of Onions, weighing
four

four ounces Troy, into a quart bottle containing common air; and introduced; at the same time, two small bulbs of the same kind into another bottle of equal capacity. The vessels were then securely stopped, the corks being covered with wax and pieces of wet bladder. The two bulbs, that were inclosed apart, began to vegetate before the end of March; and had sprouts nearly three inches long, before the middle of April: No signs of vegetation ever appeared in the larger parcel. The two bottles were opened on the twenty-second of May, being first inverted in water, when a quantity of gas, containing a considerable portion of *carbonic acid*, issued from both of them; particularly from that where the onions weighing four ounces were lodged, which continued to discharge numerous bubbles of a foetid elastic fluid through the water, for more than a quarter of an hour, which was as long as I attended to the subject. The sprouts of the two bulbs were flaccid, and evidently in a state of decay: their vegetation undoubtedly ceased when the *oxygen* in the bottle was consumed; upon which the putrefactive fermentation commenced, and destroyed their texture. The Onions of the other parcel did not vegetate when exposed to the atmosphere, but became soft and rotted. The great discharge of gas, which took place when the bottle

was

was first opened, proves that they were predisposed to putrify, the elastic matter being compressed in their pores solely for want of room to expand in; and the subsequent part of the experiment shews, that they were too much injured to be reclaimed by the action of the air.

EXPERIMENT XIII. About the middle of February I placed two small onions, on a muslin strainer, in a glass jar which contained *azote* and stood in water. They remained in this situation nearly six weeks without altering the least in appearance, though some bulbs of the same kind, standing in an open glass on the same shelf, vegetated vigorously before the conclusion of the experiment. We may venture to infer from the two last experiments, that what has been hitherto proved, respecting the vegetation of *seeds*, is also applicable to that of *bulbs*; with this difference: that the former must be prepared to make them sprout, by receiving an accession of humidity from an external source, which the latter do not require; because they naturally contain within themselves a portion of water sufficient for the purpose. Hence it happens that seeds, particularly such as are natives of temperate climates, may be conveyed to a great distance merely by guarding them from humidity, which cannot be done, with bulbs; for they soon vegetate, in a proper

temperature,

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temperature,

temperature, if not deprived of *oxygene*, without which they begin to putrify in a short time.

The preceding experiments relate almost entirely to the first period of vegetation, during which the rudiment of the future root comes into view from between the seed-lobes ; and, as this is the commencement of the process, it does not appear improbable that the extraordinary *stimulus*, which is required to excite the latent energy of the germ, ceases to be of use as soon as the effect is accomplished. For a number of experiments, made by that industrious Philosopher Dr. Priestley, prove that plants are capable of living and growing in *azote*. From whence it would appear, that a change takes place in their nature, at a period subsequent to the commencement of vegetation ; which supposition can only reconcile what has been delivered, in this and my former paper on the same subject, to the doctrine that has been very powerfully supported, by the labors and authority of a man of the highest reputation in the philosophical world. The following article will however prove, that the infant plant does not undergo the alteration last pointed out, while the seed-lobes supply it with nutriment.

EXPERIMENT XIV. On the eighth of April, I put twelve peas into *azote*, confined in a glass jar inverted in water. They had been previously permitted

permitted to sprout in wet sand, contained in another pot covered with a lid to exclude the light; and the rudiments of their roots, which appear first, were at that time from one inch to one inch and a half long, being undivided and of a conical figure. In this situation they remained till the fourteenth, in a window looking to the the East, without making a visible progress in growth: they were therefore taken out of the jar, and the longest sprout, being compared with a measure to which it exactly corresponded on the eighth, was found not to have altered in the least. An equal number of peas, in the same state, were placed under a jar containing common air, standing in the same window at the beginning of the Experiment. In these, vegetation made a visible progress; for the upper extremity of the sprout appeared in most of them on the twelfth, which soon assumed a green colour, from the action of light: But though the experiment was prolonged to the twenty-second, in which time the roots attained the length of four inches at least and became branched, they still preserved their primitive whiteness. The same experiment was repeated between the twenty-second and twenty-eighth of the same month, with two parcels of sprouted beans; and the result corresponded exactly to the facts that have now been stated.

EXPERIMENT XV. Six seeds of white mustard (*Sinapis alba*) were planted, about the middle of March, in a glass bottle; the bottom of which was covered with moist earth, the upper part being occupied with common air. The mouth was then well corked, and secured with cement. The young plants pushed their tips into view in the course of a few days, and appeared in a thriving condition; but began to droop before the end of the week, and died in a short time after. The air was found to be unfit for combustion. Probably the wet mould confined in it contributed not a little towards depriving it of its *oxygen*; for the mud of rivers and ponds has been discovered to possess this property in a high degree.

The facts related in the two last articles prove, in a clear manner, that seeds which have been permitted to grow for a time in the atmosphere, cease to do so when they are surrounded with *azote*; whence it may be safely inferred, that a germ in the act of vegetation requires to be continually excited by the stimulus of *oxygen*. But as soon as the seed lobes are exhausted, the young plant is in a state to derive its nutrition from the ground; and then (and not till then) it finds itself in a situation capable of making future advances, unassisted by the stimulus of respirable air.

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The infant sprout at first suffers only a suspension of its energy from the absence of pure air; but if this necessary support be withheld too long, it perishes by the putrefactive fermentation: For if seeds treated as in EXPERIMENT XIV. be taken out of the *azote* in which they are confined, at the end of two or three days, they begin to vegetate afresh with unimpaired vigour; but if their stay in the gas be protracted three or four days longer, when the weather is moderately warm, they lose their natural color, and putrify.

EXPERIMENT XVI. The lively green, which the stems and leaves of plants receive from the action of light, cannot be imparted to them, provided the energy of the vegetative principle in them be suspended: for after permitting a number of peas to produce both extremities of their sprouts in wet sand covered from the light by an earthen pot, I placed five of them, on the twenty-ninth of April, in an inverted glass jar, containing *azote* confined by water; and three in another jar, in which a portion of common air was also inclosed by the same means. On the thirtieth, the upper extremities of the sprouts of the parcel last mentioned were green; but, though the Experiment was prolonged to the second of May, those in the other glass did not exhibit any perceptible alteration in size or color.

color. Two of them were now placed in a glass filled with atmospheric air, where they were left unobserved to the fifth, at the end of which time the germs had vegetated considerably; the lower parts of them still remained white; but their opposite extremities had changed to their proper green. It may here be remarked, though the observation has but little connection with our present enquiry, that the circumstance of the inferior part of the germ in Peas and Beans constantly preserving its primitive whiteness, may be considered as a proof of the roots of Annuals being different in their internal structure to Perennials, Shrubs, and Trees; for many instances have been noted by naturalists, some of which are recorded in the second volume of Lowthorp's Abridgement of the Philosophical Transactions, (Page 673) of the branches of woody vegetables taking root when planted in an inverted position, and producing perfect plants in this unnatural posture: which shews that the rudiments of all the different fibres appertaining to a complete vegetable are comprised in a particular part of it, when this is the case. But the circumstance just now mentioned, is a strong evidence of a contrary nature in annuals: for, since the rudiment of the root is not susceptible of a green color, it is plain that the part in question is destitute of something

something which is natural to the stem, and its appendages. Hence we perceive, that though a perennial may by accident become an annual, the contrary cannot possibly take place. In the course of May I repeated the last experiment with Beans; and the event of this trial corresponded exactly to what has been already said on the subject. Hence it may be safely inferred, that *greenness* cannot be imparted to the sprouts of seeds without the joint action of *light* and *oxygen*; in which they are very different from the shoots that frequently proceed from maturer plants, when secluded from the atmosphere: for, as these grow freely in close glass vessels, placed in a window, and containing water and *azote*, the parts which are recently produced continue to vegetate, in consequence of their connection with the parent stock, and acquire the color in question without the assistance of respirable air, as is evident from the following article:

EXPERIMENT XVII. On the second of July, I introduced a slip of Spear-mint into a six-ounce-phial, in such a direction that the end of its stalk remained in the neck. The bottle was then filled with river water; and, being inverted in a vessel of the same, about four ounces of the water were displaced by *azote*: after which the mouth was stopped with a cork in
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the vessel, and a thick covering of cement was applied after the glass had been made dry with a cloth. These precautions were used with a view to intercept all communication with the external air. The bottle was then exposed to the light in an inverted position, so that the extremity of the slip was in the water, and its top remained in the inclosed gas. The leaves began to wither in a few days, and a number of fresh shoots appeared in their places, both under the water and above its surface, before the tenth, which were green and clothed with leaves. This experiment appears to prove clearly that parts, which are in a condition to grow without the help of respirable air, can give a green color to such fresh sprouts as they may chance to produce when separated from the atmosphere, provided the *light* shine on them. We also know that the functions of vegetables are but imperfectly performed during the sun's absence. They perspire, upon an average, ten times more in twelve hours of day, than in an equal space of night. When exposed to a moderate light, they discharge *oxygen* freely; this process ceases as soon as they are removed into the dark. Many herbs fold up their leaves at sun-set, close their blossoms, and experience a kind of *torpor* analogous to the sleep of animals, during which their internal œconomy is suspended.

pended. LIGHT is therefore the chief exciting power, in adult vegetables, which gives activity to their different organs; and hence greenness, which indicates a plant to be in a healthy state, arises from its juices being properly assimilated; to which the influence of the solar rays contributes, by giving its vessels their necessary tone. Thus the different secretions required in its œconomy are elaborated; its fibres receive their just texture; and the hue, which Nature has diffused so universally over this part of creation, bespeaks its vigor and prosperity. But *oxygene* discharges that function in seeds, which *light* discharges in maturer vegetables; and this temporary difference, in the nature of the same organized body, is a wise precaution: for, since the germ is intended to expand itself in the ground, the author of the universe has endued it with properties susceptible of necessary impressions, from a cause that has free access to its dark retreat.

With the assistance of this agent, it performs a kind of imperfect vegetation; which continues till the rudiment of the stem breaks the soil and comes into day, where it immediately experiences the influence of the light; which, by producing a change in its colour, gives it the appearance of a plant.

All the preceding conclusions apply solely to plants growing on dry land: for it is evident, from a slight consideration of the subject, that the æconomy of *aquatic* vegetables consists of a class of habits of a very different nature; which cannot be rightly understood, until they be investigated by a course of experiments.

*An Attempt to explain the NATURE and ORIGIN
of the ANCIENT CARVED PILLARS and OBELISKS,
now extant in Great Britain. By Mr. THOMAS*

BARRITT.

READ DECEMBER 26, 1794.

ANTIQUARIANS are often accused of a superstitious devotion to the objects of their research. The present essay will, at least, be freed from this imputation; for I intend to shew, that many stone monuments in this country have been referred to a period too remote, by those who have hitherto examined them.

Some rude masses of stone are, indeed, to be seen, particularly on the coasts of Scotland, which were probably erected immediately after battles

battles with the Danes and Norwegians; but I am inclined to believe that all the figured pillars and obelisks, which have been supposed monuments of similar events, were crosses, either erected on conspicuous places to excite devotion, or raised over the burying places of noble families, or designed to commemorate military transactions, of a much later period.

The crusades, and the science of heraldry, gave birth to multitudes in unnumbered forms, which no one but a student in arms can possibly have a knowledge of. Indeed an acquaintance with heraldry is, if of no other use in these days, absolutely necessary as an auxiliary to the study of British antiquities; and without it an enquirer is liable to unavoidable difficulties, if not to very great mistakes, so close a connection subsists between many parts of heraldry and antiquity. After the barrow and the tumulus of the Pagans, stone crosses were introduced by the Christians. Many of them are at this day in a state of great decay, and others entirely gone, their existence being only ascertained by the name of the spot on which they once stood.

Besides the injury which their ornaments and imagery have undergone from the mouldering hand of time, and wanton ignorance, they have suffered much from the blind zeal of reformers; who having no taste themselves, and being re-

gardless of art, under a pretended shew of piety and of eradicating superstition, have totally destroyed some, and so defaced and mutilated others, by breaking off their ornamental and flowered cross-tops, as to give them the appearance of nothing more than obelisks, or rude pillars. Thus under their present form, some have imagined, that several crosses in Britain are the work of northern Pagans, and supposed them Runic antiquities of this island.

It must be admitted that some ancient obelisks may have been consecrated, by the addition of crosses, or other emblems of Christianity. To-land, in his history of the Druids, P. 84, says, " We read of many such obelisks thus sanctified, as they speak, in Wales and Scotland. " And in our Irish histories, we find the practice " as early as Patric himself; who, having built " the church of Donart-Patric, on the brink of " Lock-Hacket, in the county of Clare, did " there on three colosses, erected in the times " of Paganism, inscribe the proper name of " Christ in three languages: namely, Jesus in " Hebrew on the first, Soter in Greek on the " second, and Salvator in Latin on the third."

A little caution ought to be observed, in decyphering their ornaments, or explaining them to be hieroglyphical; although abundance of imagery, curious grotesque figures, and tracery
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yet exists upon some in Scotland; and one at Bew-Castle, in Cumberland, had upon it, if it has not now, a verse, in characters said to be Runic, in good preservation: But this obelisk, like several others, has had its top broken off, and leaves a suspicion behind of its having been once a cross.

Few persons at present will allow the grotesque and whimsical figures in and on the outside of our old churches, and upon the margins of our old illumined missals, to have any reference to particular persons or accidents in general, but think them merely the whim of the workman; who, I suppose, was left to his own choice: for I can scarcely persuade myself the clergy of that period would have permitted such exhibitions upon oak, as are sometimes to be met with under the seats of stalls, in our cathedral and collegiate churches, had they superintended such works themselves.

The obelisks in "Cordiner's Views of Scotland," and that in Nithsdale, described by Capt. Riddell, one of our late worthy members, and engraved in the memoirs of this Society,* and several others described and engraved in Pennant's Tour in Scotland, at Aberlemno, Meigle, and Forres, are all sculptured with grotesque figures, chain-work, love knots, and ramifying tracery; and where the delineation
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* See Vol. IV. Part I. p. 131.

of a cross does not shew itself upon any of their sides, the probability of the summit having once been crucial, does not seem to have occurred to antiquaries.

It is probable that the reformation was the great period of destruction for the cross-tops; what was then left standing was demolished during the civil war.

The three stone-pillars in the church-yard at Penrith, in Cumberland, a drawing of which I made in the year 1791, and have here given, together with one, representing what I suppose might have been their original state, have been examined by many; but all have mistaken their original destination. One says, he saw nothing in them but "pillars rude from the chisel."

Stukeley, in his *Iter Boreale*, page 46, says, "in the church-yard of Penrith is a monument of a giant, Sir Owen Cæsarius, a knight I suppose of their king Arthur; two pyramidal stones, with rude carvings and letters on them, seemingly Runic" — He takes no notice of the four intervening stones.

Mr. Pennant, in his tour 1769, gives two engravings of these pillars: one in their present state, and the other before the mutilation took place. The pillars in his views are square, and figures of boars are carved upon the side stones; the drawings of both were sent him by two obliging friends;

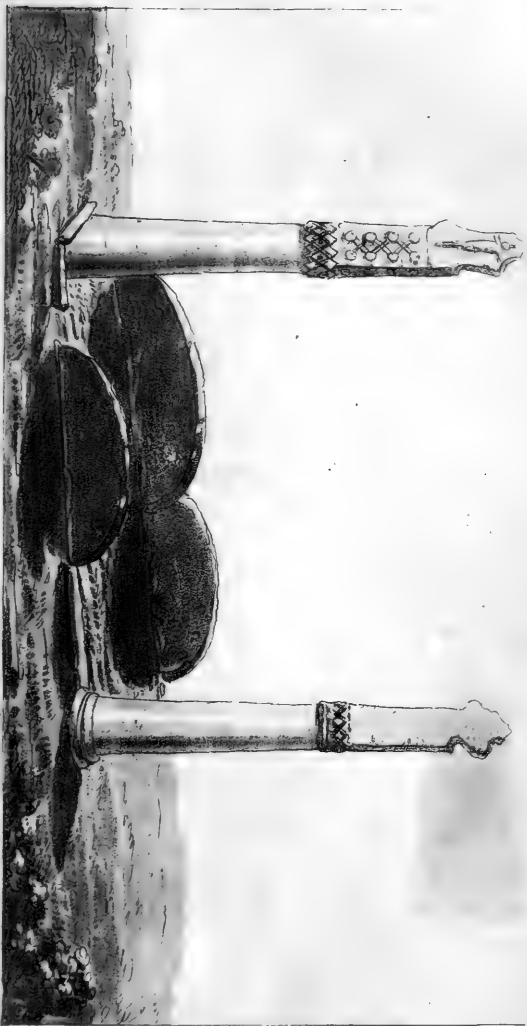
friends ; but the slightest observer can hardly suppose, that what is represented in the one ever existed in the other. Mr. Pennant says, " How this great variation in the drawings of the same columns happens, is not easy to say ; for it does not appear that there ever were any other in the place. Time has obliterated the figures of the animals ; but whether any workman has chiselled the whole shafts of the pillars to their present form, is, I think, scarcely to be conjectured : they bear all the appearance of antiquity." He says again, he has his " doubts about the entire fidelity of the old drawing, which was done about the year 1690." I think there is little doubt of its being a forgery, when compared with the monument.

Another writer represents these pillars under the character of Boar-spears, supposing they stood for the memorial of some ancient Nimrod, famous in the chase ; and the four flat-side stones, remaining upon their edges, betwixt them, to be the worn-out shapes of boars, or bears, before the Christian æra. The fact seems to me to be this ; that it is the decayed tomb of some now forgotten Cumberland or Westmorland Nobleman, with a cross at the head, and another at the feet, the shafts of which only are remaining ; and that the four stones betwixt them are the remains of the tomb.

The

The pillars are about eleven feet high, and about fifteen feet asunder; the lower parts are round, without ornaments, the upper part of the shaft terminating pyramidally, and chased with a fret-work, curiously interlaced through rows of annulets or rings. Upon one of the tops, on the outside, are still apparent to a nice observer, the faint remains of a crucifix (not a simple cross alone, as given in the above-mentioned tour) which prove it to be christian. I was pleased in this discovery, as that good judge in these matters, Dr. Ferriar, was with me. Upon one of the side stones, are ornaments, which are the only tracings, I conceive, that any one can imagine to be runic characters; but when closely examined, they prove only knot-work, or an imitation of running branches, like the ramifying tendrils of the vine; whereas the letters denominated runic wear no such twisted or incurvated appearance: and no such figure as a boar could ever have been carved thereon, though time, and school-boys play, may have given them their present form, in some degree resembling the back of a hog.

The crucifix above mentioned is placed in the centre of one of the crosses, once surmounting the tops of the pillars, which like the Nithsdale cross, and that at Bew-Castle,
has



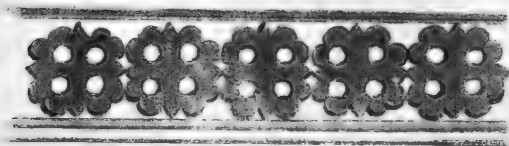
T. Darnall del.

MONUMENT IN PENRITH CHURCH YARD.

J. M. M. and J. W. sculp.



Parapet at Carlisle.



Nithsdale Pillar.



Giants Thumb.





T. Barritt del. Monument in Penrith Church Yard supposed in its original state. F. M. Atwood sculp.



has now lost its flowers, or branches. I make use of these terms, as implying a remarkable distinction from the common simple Greek or Latin cross, which is only composed of two cross beams; the latter with a long shaft or pillar, the former with the pillar and arms always of equal length.

In this circumstance, I must now call in the assistance of heraldry. Having, some little time before I saw the Penrith pillars, been at Carlisle, and examined the structure of the cathedral, I could not help remarking, that one part of the parapet was crowned in a long range, with what is called in heraldry the Cross Patonce. The sweeps or flowerings uniting their extremities with each other, formed a rich embattlement to that ancient structure: this I conjecture to be the part said to be renewed in the time of King Edward the Third; these crosses having their flowerings much curved like those represented in the plate, which exhibits to the eye, in each cross, four piercings: similar portions I found yet remaining upon the pillars at Penrith; and that which stands by itself, in the same church yard, called the Giants Thumb, has still the two lower holes in it, which do not appear in any other cross in arms. An artist, with the assistance of his pencil, may very easily convince any one, how and where such appropriate parts are wanting, as the segments of these

piercings or circles are plainly visible, not only upon the pillars at Penrith, but upon that at Nithsdale, mentioned by Captain Riddell. These concurring circumstances incline me to believe, that the Penrith pillars with that at Nithsdale, are about the date of the fourteenth century; and, from similarity in the style of execution, there is great probability of their having been executed by the same hand, and perhaps very near the same time with the repairing of Carlisle Cathedral.

The Nithsdale pillar I have here given in black, and the parts which I judge are wanting, in shade, that an opinion may be formed of the propriety of the above conjecture.

The Scotch pillars are described and engraved in Pennant's *Tour*; the author of which supposes them to have been Christian, from the crosses, though of varied forms, being carved upon them on one side, with many fanciful figures on the other. That at Forres is supposed to be in memory of the final retreat of the Danes; another in memory of the victory of Luncarty, where the peasant Hay and his two Sons put a stop to the panic of the Scottish army, and animated his countrymen to renew the fight.

Although the above are decorated, besides the cross, with men, horses, dogs, and grotesque animals,

mals, which are supposed to allude to the above, or to some other material circumstance relative to Scottish history, I cannot at present be brought to believe any of them to have been erected at the time when any Norwegian, Danish, or Icelandic invasion took place in Scotland: the workmanship bespeaks the execution of a later period. The knots, foliage, and grotesque imagery, in a great degree, correspond with the embellishments of the Penrith and Nithsdale pillars; and I judge them to be nearly of the same date, of the fourteenth century. When this style was first introduced, I cannot say with certainty; but I have frequently seen it exhibited in old houses, the screens of burying chapels in churches, and ornaments in books of so low a date as the sixteenth century.

There is a cross remaining on the spot where the battle of Hedgley Moor, in Northumberland, was fought, in the reign of King Henry the Sixth. The shaft is entire, and is filled with the bearings of the Percy family, and their alliances; the capital at present has the form of a fleur de lis, having perhaps been broken, like the crosses at Penrith. This proves, that crosses were sometimes erected as military monuments. The broken capital of another cross, with some remains of sculpture, lies also in the Park opposite to Alnwick Castle, on the spot where Malcolm Canmore, King of Scotland, is said

to

to have been slain while he was besieging that fortrefs. This capital at present has the form of a fleur de lis; but as the most ornamented crosses, whether devotional, or family monuments, which remain perfect in the Western Isles of Scotland, have the crosses inclosed in a quatrefoil,* it is easy to conceive how this figure might be produced, by breaking the top and outer limbs of the circles.†

Meteorological

* See Pennant's Voyage to the Western Isles.

† A cross formerly stood near Wigan, to which the following story relates. Mabel (daughter and co-heir of Hugh Norris, Lord of Sutton, Raynhill, Whiston, Haigh, Blackrod and Leigh, and wife to Sir William Bradshaw, of Haigh, in the neighbourhood of Wigan) during the ten years absence of her husband, who was reported to be slain in the Holy War, married Sir Osmund Neville, a Welsh Knight. Sir William returned, and asked alms at Leigh, in the habit of a Palmer. Mabel, struck with this resemblance of her former husband, fell a weeping, for which she was severely reproved by Sir Osmund. Sir William then made himself known to his tenants; and Sir Osmund, on receiving the intelligence, fled towards Wales; but, near to Newton Park, in Lancashire, Sir William overtook, and slew him. Mabel was enjoined by her confessor to do penance whilst she lived, by going once every week barefoot and barelegged from Haigh to the above mentioned cross near Wigan, which was called Mab's Cross from the above occasion.

The far-worn effigies of Sir William and Lady Mabel now remain in the chancel of Wigan church. He with his hand upon his sword, and a shield charged with two bends upon his left arm; she is in a long robe, and veiled, with her hands elevated, as at prayer,

METEOROLOGICAL OBSERVATIONS, *collected and arranged by* THOMAS GARNETT, M. D. *Physician at Harrogate: Member of the Royal Medical, Royal Physical, and Natural History, Societies of Edinburgh; of the Literary and Philosophical Society of Manchester; of the Medical Society of London; of the Royal Irish Academy, &c. Communicated by* Dr. PERCIVAL.

READ, MARCH 27, 1795.

IT is properly observed by a late writer, that there is scarce any subject in which mankind feel themselves more interested, than in the state of the weather; that is, in the temperature of the air, the influences of wind, rain, &c.* It forms a principal topic of conversation. By the weather the traveller endeavours to regulate his journies, and the farmer his operations; by it plenty and famine are dispensed, and millions are furnished with the necessaries of life. It is intimately connected with the health of the human body, with every part of natural history, and particularly with agriculture. On account of the extensive nature of the subject, meteorology has long engaged the attention of philosophers; and many ingenious and plausible conjectures on the

* Adams's Lectures on natural philosophy, vol. 4.

the nature of rain, and other meteors, have been given to the public; but the facts of which we are at present possessed, are too few in number, and have been made at places too remote from each other, either to refute or confirm the theories in question.

In the first part of this volume is given an account of a number of meteorological observations made on the western coast of this island. Since the publication of that memoir, I have received journals from different parts of the kingdom, and have prevailed on several philosophical friends, in various counties, to keep registers of the barometer, thermometer, rain, wind, &c. By these means I hope we shall, in time, supply the deficiency of observation, and enable the philosopher to correct his theory by facts.—It is in the power of the Society greatly to promote this undertaking; and it would contribute greatly to the attainment of the object, if they would furnish intelligent persons in different parts with proper instruments, on condition of their transmitting annually an account of their observations: and it might perhaps be right to stimulate to such exertions, by conferring an honorary premium on those who have made accurate observations for a certain number of years.

A publication has lately appeared called the *Meteorologist's Assistant* in keeping a diary of
the

the weather, which will be of great use to those who have not been accustomed to make such observations, and will save much labour to those who have. It contains ruled columns for a register of the barometer, thermometer, hygrometer, and wind, at three periods in every day, and the quantity of rain falling each day, with columns for particular and general observations. Perhaps one still more convenient might be drawn up, and printed at the expence of the society.

The subject of Meteorology is treated in a very philosophical and satisfactory manner by Dr. Darwin, in the first volume of his Botanic Garden. The theory of the winds there given, bids fair to explain most of the meteorological phenomena.—And, I am of opinion, that if registers could be kept so as to determine at what hour the winds began to change in many parts of the world, something concerning the weather might be learnt: for, (as Dr. Darwin observes, in a letter which I lately received from him) the variation of the course of the wind seems to be the cause of, or key to, the other phenomena of frost or rain; and this, which is the principal circumstance in atmospheric theory, is most deficient in experiments.

For the convenience of comparing the different parts of the following observations, I have divided

divided the memoir into different sections. The first contains the different observations which have been made on the Barometer. The second contains observations and remarks on the Thermometer. In the third is an account of the quantity of rain which has fallen in different parts of the kingdom, with some remarks on the imperfections of rain gages, and the methods of remedying them. The fourth section contains an account of the different observations made on the winds. To these I have added, by way of Appendix, the remarks of several correspondents, which could not properly be referred to any of the preceding divisions.

§ I.

OBSERVATIONS on the BAROMETER.

OBSERVATIONS on the BAROMETER at Liverpool
for twenty-five Years, abstracted from a
a Journal kept by Mr. HUTCHINSON, late
Dock-Master of that place.

1768.

	Mean Height.	Highest.	Lowest.
January	29,37	29, 8	28, 9
February	29,16	30, 0	28, 6
March	29,76	30, 1	29, 3
April	29,46	30, 0	29, 2
May	29,34	29, 4	29, 3
June	29,56	30, 5	29,35
July	30,26	30,33	29,20
August	29,86	30,15	29,35
September	29,75	30,17	28,87
October	29,77	30,23	29,20
November	29,61	30,23	28,35
December	29,72	30,33	28,95

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1769.

1769.

	Mean.	Highest.	Lowest.
January	30,18	30,30	29,35
February	29,68	30,20	29,25
March	30,03	30,48	29,10
April	29,92	30,35	29,04
May	29,36	30,54	29,15
June	29,95	30,22	29,55
July	29,74	30,33	29,65
August	29,83	30,15	29,62
September	29,85	30,18	29,22
October	30,16	30,52	29,30
November	29,88	30,55	29,25
December	29,97	30,56	28,55

1770.

	Mean.	Highest.	Lowest.
January	30,44	30,70	29,40
February	29,31	30,57	28,75
March	30,19	30,20	29,40
April	29,83	30,60	29,20
May	29,86	30,30	29,25
June	29,84	30,18	29,58
July	30,02	30,33	29,55
August	30,12	30,35	29,90
September	29,48	30,28	29,43
October	29,76	30,40	29,08
November	29,34	30,15	28,85
December	29,45	30,20	29,10

1771.

1771.

	Mean.	Highest.	Lowest.
January	29,81	30,20	29,10
February	30,02	30,50	29,35
March	29,95	30,40	29,35
April	30,09	30,45	29,73
May	29,61	30,23	29,40
June	30,06	30,33	29,48
July	29,86	30,15	29,45
August	29,72	29,97	29,40
September	29,85	30,30	29,55
October	29,65	30,35	29,20
November	29,99	30,50	29,25
December	29,46	30,25	28,65

1772.

	Mean.	Highest.	Lowest.
January	29,57	30,25	28,75
February	29,40	29,85	28,92
March	29,17	29,92	28,85
April	29,76	30,15	29,20
May	29,47	30,32	29,40
June	29,86	30,20	29,45
July	29,85	30,25	29,20
August	29,75	30,12	29,20
September	29,67	30,10	29,10
October	29,73	30,15	29,10
November	29,49	30,25	28,60
December	29,83	30,33	29,20

1773.

1773.

	Mean.	Highest.	Lowest.
January	29,66	30,30	28,50
February	29,38	30,50	28,60
March	30,04	30,32	29,55
April	29,78	30,40	28,93
May	29,71	30,35	28,65
June	29,81	30,05	29,45
July	29,91	30,17	29,65
August	29,59	30,15	29,43
September	29,61	30,00	29,10
October	29,66	30,23	28,85
November	29,53	30,35	28,25
December	29,64	30,15	29,17

1774.

	Mean.	Highest.	Lowest.
January	29,50	30,20	28,72
February	29,64	30,42	28,90
March	29,77	30,28	29,05
April	29,70	30,25	29,20
May	29,97	30,12	29,25
June	29,77	30,17	29,45
July	29,84	30,17	29,48
August	29,81	30,22	29,35
September	29,36	30,22	28,95
October	30,01	30,43	29,32
November	30,82	30,28	29,15
December	30,01	30,67	29,05

1775.

1775.

	Mean.	Highest.	Lowest.
January	29,69	30,12	29,05
February	29,60	30,32	28,65
March	29,40	30,50	29,00
April	30,00	30,40	29,50
May	30,03	30,20	29,80
June	29,86	30,20	29,60
July	29,56	30,10	29,52
August	29,73	30,00	29,30
September	29,72	30,00	29,35
October	29,76	30,23	28,65
November	29,77	30,33	28,87
December	29,95	30,45	28,57

1776.

	Mean.	Highest.	Lowest.
January	29,73	30,20	29,25
February	29,35	29,95	28,67
March	29,84	30,32	28,87
April	30,15	30,42	29,70
May	30,00	30,43	29,10
June	29,80	30,32	29,50
July	29,79	30,28	29,15
August	29,75	30,20	29,35
September	29,80	30,40	29,12
October	30,30	30,32	29,40
November	29,81	30,25	28,98
December	29,88	30,37	29,20

1777.

1777.

	Mean.	Highest.	Lowest.
January	29,80	30,35	29,23
February	29,68	30,12	29,15
March	29,74	30,25	28,92
April	29,97	30,42	29,15
May	29,66	30,07	29,17
June	29,85	30,35	29,63
July	29,82	30,38	29,23
August	29,93	30,40	29,50
September	30,04	30,30	29,60
October	29,73	30,25	28,30
November	29,92	30,43	28,97
December	29,87	30,23	28,93

1778.

	Mean.	Highest.	Lowest.
January	29,67	30,42	28,73
February	29,81	30,35	29,15
March	29,78	30,45	29,02
April	29,79	30,25	29,35
May	30,14	30,25	29,43
June	29,99	30,27	29,57
July	29,89	30,27	29,43
August	30,41	30,45	29,62
September	29,97	30,40	29,43
October	29,65	30,08	28,98
November	29,63	30,12	29,23
December	29,78	30,73	28,83

1779.

1779.

	Mean.	Highest.	Lowest.
January	30,27	30,65	20,72
February	30,17	30,42	29,52
March	30,16	30,60	29,65
April	29,89	30,53	29,40
May	29,91	30,28	29,57
June	29,95	30,25	29,37
July	29,86	30,35	29,25
August	30,02	30,32	29,72
September	29,83	30,10	29,28
October	29,83	30,30	29,23
November	29,94	30,35	29,15
December	29,64	30,33	28,75

1780.

	Mean.	Highest.	Lowest.
January	29,87	30,40	29,12
February	29,95	30,55	29,05
March	29,82	30,35	29,35
April	29,66	30,25	28,95
May	29,86	30,22	29,20
June	29,94	30,30	29,63
July	30,03	30,30	29,63
August	30,12	30,22	29,95
September	29,83	30,13	29,53
October	29,75	30,35	29,25
November	29,86	30,48	29,03
December	30,30	30,55	29,83

1781.

1781.

	Mean.	Highest.	Lowest.
January	29,89	30,68	29,13
February	29,39	30,30	28,80
March	30,19	30,45	29,97
April	29,41	30,22	29,27
May	29,96	30,37	29,65
June	29,74	30,23	29,50
July	29,89	30,32	29,50
August	29,73	30,23	29,23
September	29,78	30,22	29,33
October	30,03	30,33	29,30
November	29,56	30,10	28,85
December	29,39	30,00	29,15

1782.

	Mean.	Highest.	Lowest.
January	29,65	30,33	28,87
February	29,81	30,33	28,90
March	29,61	30,25	28,90
April	29,56	30,32	28,40
May	29,59	30,23	28,95
June	29,93	30,42	29,35
July	29,83	30,20	29,65
August	29,52	29,97	28,95
September	29,81	30,23	29,13
October	29,74	30,18	29,12
November	29,83	30,43	29,17
December	29,94	30,37	29,35

1783

1783.

	Mean.	Highest.	Lowest.
January	29,37	30,28	28,80
February	29,59	30,55	28,30
March	29,66	30,40	28,35
April	30,06	30,47	29,45
May	29,86	30,22	29,55
June	29,79	30,20	29,10
July	29,85	30,25	29,38
August	29,81	30,18	29,48
September	29,66	30,25	28,98
October	29,78	30,23	29,30
November	29,80	30,32	29,17
December	29,84	30,32	28,95

1784.

	Mean.	Highest.	Lowest.
January	29,72	30,40	29,30
February	29,64	30,40	28,98
March	29,58	30,00	28,93
April	29,64	30,15	28,85
May	29,95	30,32	29,23
June	29,75	30,30	29,30
July	29,83	30,15	29,23
August	29,90	30,30	29,40
September	29,53	30,23	29,35
October	30,01	30,25	29,45
November	29,72	30,25	29,25
December	29,64	30,13	28,52

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1769.

1785.

	Mean.	Highest.	Lowest.
January	29,64	30,13	29,03
February	29,36	30,63	28,73
March	30,27	30,35	29,60
April	30,02	30,35	29,30
May	29,81	30,37	29,33
June	30,01	30,30	29,63
July	29,72	30,36	29,23
August	29,65	30,01	29,20
September	29,20	30,18	28,92
October	29,42	30,33	29,28
November	29,26	30,35	28,58
December	29,63	30,20	29,05

1786.

	Mean.	Highest.	Lowest.
January	29,46	30,15	28,55
February	29,67	30,25	29,02
March	29,61	30,17	29,14
April	29,80	30,35	29,38
May	30,39	30,25	29,20
June	29,81	30,22	29,62
July	29,87	30,27	29,20
August	29,68	30,15	29,12
September	29,28	30,23	28,55
October	29,55	30,33	28,45
November	29,68	30,18	28,90
December	29,73	30,33	28,60

1787.

1787.

	Mean.	Highest.	Lowest.
January	30,01	30,47	29,40
February	29,31	30,23	28,35
March	29,58	30,33	28,85
April	29,86	30,33	29,05
May	29,75	30,22	28,82
June	29,73	30,02	29,35
July	29,66	30,25	29,32
August	29,50	29,97	28,92
September	29,55	30,05	28,55
October	29,24	29,70	28,72
November	29,33	29,93	28,70
December	29,82	29,95	28,50

1788.

	Mean.	Highest.	Lowest.
January	29,55	30,20	28,30
February	29,18	29,83	28,30
March	29,57	29,70	28,93
April	29,61	30,03	28,85
May	29,61	29,95	29,22
June	29,56	29,87	29,13
July	29,47	29,80	29,18
August	29,48	30,03	28,90
September	29,40	29,75	29,00
October	29,73	30,25	29,25
November	29,65	29,95	29,20
December	29,57	29,85	29,25

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1789.

1789.

	Mean.	Highest.	Lowest.
January	29,27	30,33	28,50
February	29,22	29,78	28,25
March	29,48	29,95	28,60
April	29,44	29,87	28,80
May	29,54	29,95	29,30
June	29,54	29,95	29,10
July	29,50	29,78	29,30
August	29,74	30,05	29,42
September	29,54	30,03	29,15
October	29,32	30,00	28,55
November	29,37	30,12	28,50
December	29,45	30,25	28,70

1790.

	Mean.	Highest.	Lowest.
January	29,76	30,20	28,95
February	29,31	30,30	29,30
March	30,01	30,45	29,55
April	29,74	30,15	29,35
May	29,89	30,30	29,30
June	29,70	30,55	29,40
July	29,81	30,20	29,45
August	29,90	30,15	29,60
September	29,98	30,50	29,40
October	29,87	30,40	29,50
November	29,77	30,35	29,10
December	29,78	30,35	28,95

1791.

1791.

	Mean.	Highest.	Lowest.
January	29,39	30,30	28,35
February	29,96	30,50	29,10
March	30,16	30,65	28,90
April	29,75	30,10	29,10
May	30,00	30,40	29,50
June	29,95	30,30	29,68
July	29,79	30,25	29,35
August	29,99	30,55	29,08
September	30,09	30,35	29,45
October	29,61	30,50	28,70
November	29,68	30,95	28,85
December	29,58	30,20	29,05

1792.

	Mean.	Highest.	Lowest.
January	29,63	30,35	28,95
February	29,96	30,50	29,55
March	29,69	30,45	29,05
April	29,57	30,30	29,30
May	29,90	30,35	29,10
June	29,91	30,40	29,30
July	29,83	30,10	29,55
August	29,90	30,30	29,20
September	29,71	30,25	29,10
October	29,75	30,45	29,15
November	29,95	30,35	29,15
December	29,83	30,25	29,10

Mean

Mean annual Height and Range of the Barometer, in each of the preceding Years.

Years.	Annual Mean.	Highest.	Lowest.	Range.	Years.	Annual Mean.	Highest.	Lowest.	Range.
1768	29,64	30,33	28,06	2,27	1781	29,74	30,68	28,80	1,88
1769	29,87	30,54	28,55	1,99	1782	29,73	30,43	28,40	2,03
1770	29,80	30,70	28,75	1,95	1783	29,75	30,55	28,30	2,25
1771	29,83	30,50	28,65	1,85	1784	29,74	30,40	28,52	1,88
1772	29,61	30,33	28,60	1,73	1785	29,66	30,63	28,58	2,05
1773	29,69	30,50	28,25	2,25	1786	29,71	30,35	28,45	1,90
1774	29,80	30,43	28,72	1,71	1787	29,61	30,47	28,35	2,12
1775	29,74	30,50	28,57	1,93	1788	29,53	30,25	28,30	2,05
1776	29,85	30,43	28,67	1,76	1789	29,45	30,33	28,25	2,08
1777	29,83	30,43	28,30	2,13	1790	29,79	30,55	28,95	1,60
1778	29,87	30,73	28,73	2,00	1791	29,82	30,95	28,35	2,60
1779	29,95	30,65	28,75	1,90	1792	29,80	50,50	28,95	1,55
1780	29,91	30,55	28,95	1,60					

Hence it appears that the mean Height of the Barometer at Liverpool, deduced from an average of twenty-five years, is 29,74 inches: the greatest height, during that period, 30,95, the least 28,06: the greatest range 2,89; and the annual average range 1,96.

Mean height of the Barometer at Liverpool in each month, deduced from an average of twenty-five years.

January	29,71	May	29,80	September	29,69
February	29,58	June	29,82	October	29,71
March	29,80	July	29,82	November	29,64
April	29,78	August	29,81	December	29,64

It is evident from this statement, that the mean height of the barometer is greater during the months of May, June, July, and August, than in any other four months. And this does not depend upon the expansion of the mercury by heat, independent of its weight: for the difference in the expansion of the mercury from this cause, between the greatest cold of winter and heat of summer, never exceeds ,03 of an inch.

Observations on the Barometer at Dover, extracted from a Journal kept by Mr. T. MANTELL, Surgeon at Dover.

The observations commence in October 1789.

1789.	Mean.	Highest.	Lowest.
October	29,61	30,21	28,74
November	29,64	30,42	28,60
December	29,81	30,48	29,10

1790.

1790.

	Mean.	Highest.	Lowest.
January	30,02	30,31	29,12
February	30,21	30,49	29,67
March	30,12	30,48	29,20
April	29,63	30,16	29,16
May	29,76	30,10	29,30
June	29,93	30,22	29,29
July	29,98	30,21	29,41
August	30,16	30,20	29,71
September	30,09	30,42	29,48
October	30,00	30,40	29,60
November	29,87	30,32	29,11
December	29,97	30,38	29,10

1791.

	Mean.	Highest.	Lowest.
January	29,98	30,42	28,48
February	30,00	30,42	29,15
March	30,05	30,95	28,97
April	29,87	30,12	29,11
May	30,12	30,39	29,68
June	30,02	30,32	29,41
July	30,05	30,29	29,50
August	30,20	30,58	29,71
September	30,21	30,39	29,50
October	29,82	30,46	29,00
November	30,00	30,38	28,64
December	29,60	30,43	28,99

1792.

1792.

	Mean.	Highest.	Lowest.
January	29,65	30,46	29,10
February	30,00	30,42	29,42
March	29,80	30,38	29,10
April	30,03	30,40	29,11
May	30,08	30,36	29,39
June	29,97	30,33	29,36
July	29,90	30,24	29,51
August	30,01	30,16	29,30
September	29,76	30,41	29,60
October	29,77	30,27	29,21
November	29,91	30,41	29,38
December	29,10	30,25	29,60

1793.

	Mean.	Highest.	Lowest.
January	29,92	30,45	29,10
February	29,70	30,17	29,18
March	29,82	30,11	29,29
April	29,90	30,30	29,28
May	30,08	30,30	29,35
June	30,18	30,24	29,72
July	30,18	30,40	29,73
August	30,44	30,90	29,40
September*	30,29	30,46	29,50

X x x

Mean

* The observations to the end of the year are not come to hand,

Mean annual height and range of the Barometer in each of the preceding years.

	Annual mean.	Highest.	Lowest.	Range.
1789	29,68	30,48	28,60	1,88
1790	29,97	30,49	29,10	1,49
1791	29,99	30,95	28,48	2,47
1792	29,83	30,46	29,10	1,36
1793	30,05	30,90	29,10	1,80

Hence the mean height of the Barometer at Dover, on an average of five years, is 29,90 inches: the greatest height during that period 30,95; the least 28,48: the greatest range 2,47; and the mean annual range 1,80.

Observations

Observations on the Barometer at MIDDLEWICH, in Cheshire; from a Journal kept by S. VERNON, Esq. at the request of the late Dr. FOTHERGILL: communicated to Dr. PERCIVAL. In this Journal, Mr. Vernon has only given the greatest and least heights of the Barometer in each Month with the range, there is no way therefore of deducing the monthly mean.

	1768			1769			1770			1771			1772		
	Hight.	Lowest.	Range.	Hight.	Lowest.	Range.	Hight.	Lowest.	Range.	Hight.	Lowest.	Range.	Hight.	Lowest.	Range.
Jan.	30,15	29,39	0,85	30,10	29,30	0,80	30,60	29,24	1,36	30,12	29,05	1,07	30,36	29,36	1,00
Feb.	30,30	28,90	1,40	30,11	29,10	1,01	30,44	28,71	1,73	30,35	29,24	0,11	29,89	28,93	0,96
Mar.	30,45	29,65	0,80	30,42	28,98	1,44	29,98	29,14	0,84	30,18	29,24	0,94	30,00	28,89	1,11
Apr.	30,31	29,49	0,82	30,24	28,92	1,32	30,35	29,05	1,30	30,29	29,50	0,79	30,10	29,53	0,57
May	30,23	29,20	1,03	30,50	29,30	1,20	30,16	29,21	0,95	30,16	29,33	0,83	30,30	29,40	0,90
Jun.	30,14	29,26	0,88	30,17	29,45	0,72	30,04	29,45	0,59	30,30	29,36	0,94	30,33	29,50	0,83
Jul.	29,97	29,25	0,72	30,26	29,64	0,62	30,25	29,60	0,65	30,19	29,45	0,84	30,39	29,59	0,80
Aug.	30,09	29,30	0,79	30,10	29,52	0,58	Not observed.			30,10	29,48	0,62	30,27	29,27	1,00
Sep.	31,00	28,79	2,21	30,35	29,70	0,65	30,20	29,44	0,96	30,33	29,64	0,69	30,19	29,16	1,03
Oct.	30,14	29,14	1,00	30,45	29,44	1,01	30,35	29,04	1,35	30,50	29,30	1,20	30,27	29,16	1,11
Nov.	30,20	28,00	2,20	30,32	29,43	0,89	30,09	28,94	1,17	30,62	28,86	1,76	30,35	29,99	1,36
Dec.	30,32	28,92	1,40	30,36	28,41	1,95	30,06	29,06	1,00	30,36	28,88	1,48	30,40	29,28	1,12

Mean of the extremes, or mean ranges in each of the preceding years.

	Highest.	Lowest.	Range.
1768	31,00	28,00	3,00
1769	30,50	28,92	1,58
1770	30,60	28,71	1,89
1771	30,62	28,86	1,76
1772	30,40	28,89	1,51

The greatest height of the Barometer, during the preceding years at Middlewich, was 31,00; the least 28,00; the greatest range 3,00; and the mean annual range 1,94.

The latitude of Middlewich is $53^{\circ}. 12^{\circ}$.

Observations on the Barometer at Kendal, by Mr. J. GOUGH. Continued from p. 258.

Mean monthly heights of the Barometer.

	1792	1793	1794
January		29,902	29,871
February		29,585	29,621
March		29,756	29,800
April		29,852	29,772
May		29,014	29,901
June		29,844	29,995
July		29,934	29,917
August	29,875	29,795	29,833
September	29,644	29,895	29,805
October	29,709	29,807	29,667
November	29,876	29,727	29,505
December	29,682	29,615	29,329
			Mean

Mean annual height of the Barometer for the preceding years.

1792	1793	1794
29,759	29,810	29,793

Observations on the Barometer at Dumfries, by MR. ALEX. COPLAND. Continued from p. 272.

1793	Monthly Mean for 1793.	Above the Medium.	Below the Medium.	Medium of each Month for six Years.
January	29,8062	0,3189		29,4873
February	29,4992		0,1648	29,6640
March	29,7079	0,0303		29,6776
April	29,8232	0,1299		29,6933
May	29,8989	0,1077		29,7912
June	29,7885		0,0281	29,8166
July	29,8429	0,0358		29,8071
August	29,7311		0,1192	29,8503
September	22,8922	0,1119		29,7803
October	29,7445	0,0629		29,6816
November	29,7175	0,0956		29,6219
December	29,5713	0,0148		29,5565

The annual mean for the six preceding years is 29,7019. The annual mean for 1793, is 29,7518, which is 0,0499 above the medium.

Mean

Mean height of the Barometer at Dumfries in each season of the year 1793, compared with the mean of the same seasons for the last six years.

1793.	Medium in 1793.	Above the Medium.	Below the Medium.	Medium for six preceding years.
Spring	29,6768		0,0015	29,6783
Summer	29,8434	0,0385		29,8049
Autumn	29,7893	0,0186		29,7707
The three winter months }	29,6983	0,1431		29,5552

Barometer highest 30,45 ; lowest 28,57 ;
range 1,88,

Observations on the Barometer at Kewick, for 1793,
by MR. PETER CROSTHWAITE. Continued
from Mr. DALTON'S Meteorological Obser-
vations and Essays, page 15.

1793.	Mean.	Highest.	Lowest.	Range.
January	29,66	30,28	28,52	1,76
February	29,31	29,77	28,64	1,13
March	29,48	30,03	28,82	1,21
April	29,60	30,10	28,97	1,13
May	29,76	30,08	28,68	1,40
June	29,60	29,98	29,37	0,61
July	29,68	29,93	29,14	0,79
August	29,54	29,85	29,13	0,72
September	29,65	30,08	29,12	0,96
October	29,56	30,14	28,82	1,32
November	29,48	30,17	28,65	1,52
December	29,34	30,15	28,33	1,82

The

The greatest height of the barometer at Kefwick during the year 1793 was 30,28; the least height 28,33; the mean height 29,55; the greatest range 1,95; the mean monthly range 1,11. According to Mr. Dalton, (Meteorological Effays, p. 16) the mean annual height is 29,79, consequently the mean height for this year is ,24 below the medium.

Observations on the Barometer at York, abstracted from a Journal kept by the late DR. WHITE, and communicated by DR. FOWLER, of York.

	Mean height of barometer in 1771.	Ditto in 1772.	Ditto in 1773.	1774.		
				Mean.	Highest.	Lowest. Range.
January	29,40	29,50	29,37	29,32	30,12	28,60 1,52
February	29,87	29,45	29,56	29,65	30,50	28,80 1,70
March	29,72	29,47	30,05	29,70	30,40	29,00 1,40
April	29,95	29,75	29,70	29,75	30,40	29,10 1,30
May	29,70	29,90	29,97	29,75	30,20	29,30 0,90
June	29,81	29,87	29,83	29,82	30,25	29,40 0,88
July	29,81	29,81	29,95	29,92	30,27	29,60 0,67
August	29,67	29,71	29,82	29,77	30,30	29,25 1,05
September	29,97	29,50	29,50	29,65	30,30	29,00 1,30
October	29,62	29,67	29,62	29,90	30,51	29,30 1,21
November	29,92	29,57	29,32	29,62	20,25	29,10 1,15
December	29,51	29,80	29,62	29,97	30,75	29,20 1,55

The reason why the greatest and least heights are only given in the year 1774, is because I received only an abstract of Dr. White's Journal for the preceding years containing the mean heights, but the complete Journal for the year 1774.

Mean height of the Barometer in each of the preceding years, with the annual Range in 1774.

	Mean height.	Highest.	Lowest.	Range.
1771	29,74			
1772	29,66			
1773	29,69			
1774	29,73	30,45	28,60	2,15

It appears from hence, that the mean annual height of the Barometer at York, on an average of four years, is 29,70. The greatest height during the year 1774, was 30,75; the least 28,60: the greatest range 2,15; and the mean range 1,21.

Observations on the Barometer at Harrogate.

1794	Greatest height.	Least height.	Mean.
June	29,80	29,21	29,38
July	29,85	28,90	29,25
August	29,72	28,85	29,01
September	29,75	28,60	29,32
October	29,81	28,45	29,21
November	29,65	28,60	29,15
December	29,85	28,95	29,24
			Mean

Mean height of the Barometer at different places, with the number of years for which the mean was deduced.

Liverpool.		Dover.		Kendal.		Dumfries.		Kewswick.		York.	
Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.	Years.	Mean height.
25	29,74	4	29,90	8	29,78			5	29,72	4	29,70

If these numbers were deduced from observations for a great number of years, they would afford a means of ascertaining the respective heights of the barometer at each place above the level of the sea. None of the above however can be depended upon, excepting those at Liverpool, the others having been made far too short a space of time to give the true means.

I shall conclude these observations on the Barometer, with a table of the space moved through by the mercury in the barometer at Kendal, for six years, which was communicated to me by Mr. Gough. He observes that, "the barometer

Y y y

" has

“ has been long valued for indicating the
“ changes of the weather; and philosophers
“ have not (as far as he knows) made any
“ use of it, besides remarking the mean and
“ extreme heights of the mercury; circum-
“ stances which are much influenced by local
“ elevation: but tables expressing the spaces
“ moved through by this fluid in the tube,
“ for the several months of a series of years,
“ promise to be of more service to science.
“ For, by comparing part of that which follows,
“ with one made from the observations of the
“ Royal Society, I find (says he) that the
“ motion in question, as well as the rain, is
“ much less at London than at Kendal. I do
“ not pretend to account for this curious cir-
“ cumstance. Meteorology is too near a state
“ of infancy to admit of complete explanations.
“ Facts not theories are what we want; and if
“ they be ever obtained, the joint labours of many
“ observers must supply them. The tables here
“ recommended are liable to some imperfec-
“ tions, which need not be pointed out to those
“ who understand the structure of the instru-
“ ment. The inaccuracies are considerably
“ diminished in mine, by the basin and tube
“ of the barometer being wide; and by taking
“ the observations three times a day, which is
“ also done with the thermometer.”

Space moved through by the Mercury in the Barometer
at Kendal for six years.

	1788	1789	1790	1791	1792	1793	Mean
January	10,75	10,76	8,53	13,84	8,32	7,28	9,946
February	7,31	10,63	5,85	9,01	7,01	9,30	8,185
March	7,12	6,98	4,03	6,74	9,63	8,44	7,156
April	6,62	7,49	4,44	5,64	5,77	5,88	5,973
May	4,62	6,20	4,56	6,18	6,89	5,59	5,673
June	3,19	4,88	4,94	2,48	5,03	4,32	4,223
July	4,81	4,18	6,46	5,70	5,25	4,39	5,131
August	4,25	3,87	4,65	5,54	5,50	6,42	5,036
September	5,62	5,41	6,43	5,89	8,19	5,94	6,246
October	5,25	7,13	6,30	7,48	5,92	6,50	6,430
November	6,38	7,14	7,88	7,68	7,74	5,77	7,098
December	5,71	9,76	12,93	11,23	13,41	7,42	10,076
Total	71,63	84,43	77,00	87,41	88,66	77,95	81,173

Captain Burton, of Ripon, lately shewed me an improvement which he had made in the index of the barometer, which may be of use to observers, and particularly in the mensuration of heights by means of that instrument.

(Pl. IX. Fig. 1.) *A* is a micrometer-screw, containing two hundred threads in an inch:

Y y y 2

the

the bottom of it is fastened to the index *C*, which it moves up and down the $\frac{1}{200}$ part of an inch at every revolution. Behind *B* is a wheel, containing two hundred teeth, which are moved by the threads of the screw. This wheel carries the index *B*, which moves round the graduated circle divided into two hundred parts, while the screw moves one inch.—The screw *A* is moved by the hand, till the index *C* be exactly on a level with the surface of the mercury; and the index *B* shews the height of the fluid.

§ II.

OBSERVATIONS ON THE THERMOMETER.

Observations on the Thermometer at Liverpool, extracted from MR. HUTCHINSON'S Journal.

These observations on the Thermometer were made at twelve o'clock at noon. The Thermometer was raised about forty feet above high-water-mark. It was placed under a table (to prevent the rain having any effect upon it) facing the North, in an open observatory at the top of house. The house was considerably elevated above the adjoining ones; and the observatory was as much exposed to the open air as possible.

	1768.			1769.			1770.			1771.			1772.		
	Mean.	Highest.	Lowest.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	40	52	29	48	53	42	46	57	37	42	56	41	44	52	40
February	50	58	43	48	53	44	49	57	41	48	56	40	44	53	38
March	51	56	47	52	57	45	46	53	42	48	56	43	49	55	41
April	56	59	51	55	64	47	51	57	48	53	59	47	54	59	48
May	61	68	50	59	66	54	*	†		61	67	54	55	63	50
June	64	71	55	61	62	60				64	74	57	66	72	55
July	66	70	63	68	78	60				65	73	60	67	75	64
August	65	70	61	64	70	61				63	69	60	66	71	62
September	60	65	58	62	69	56				61	67	58	62	67	57
October	58	63	55	56	62	50				58	64	54	63	65	56
November	51	55	47	55	57	44				52	58	48	52	57	48
December	46	57	40	48	55	44				51	55	47	49	55	40

* Observations on the Thermometer only for the first six days of this month.

† No more observations on the thermometer this year.

	1773.	1774.	1775.	1776.	1777.										
January	50	57	46	44	49	40	50	57	44	42	52	34	42	55	34
February	44	56	42	48	54	43	53	58	50	48	52	34	39	53	32
March	53	61	48	53	60	48	53	57	47	53	62	48	50	68	34
April	55	62	50	56	64	52	60	71	54	58	62	54	51	60	42
May	57	67	50	59	66	52	61	67	54	59	67	52	57	64	50
June	63	70	59	63	66	59	69	76	62	61	69	59	61	70	52
July	65	73	60	64	68	61	67	72	62	66	70	64	66	78	57
August	69	76	62	67	72	64	66	71	63	64	73	61	64	79	56
September	69	68	56	62	68	59	64	72	60	63	70	60	64	77	54
October	58	64	55	61	67	54	58	67	50	59	65	56	55	66	46
November	51	58	45	52	63	44	51	57	46	53	62	43	48	58	40
December	50	55	46	49	55	39	52	62	45	51	60	44	39	53	31

	1778.			1779.			1780.			1781.			1782.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	39	48	31	41	52	32	34	44	24	36	52	24	45	50	34
February	41	50	34	53	66	44	39	50	32	45	50	40	39	52	32
March	45	56	36	54	66	44	50	59	44	54	60	40	42	50	34
April	52	74	41	56	70	50	47	58	44	56	68	48	43	54	34
May	61	72	52	61	78	48	59	80	50	60	84	50	50	64	44
June	66	77	52	66	76	58	61	84	55	66	82	54	61	78	44
July	66	78	58	73	88	64	68	78	58	69	83	56	63	78	54
August	69	81	60	73	84	64	75	82	66	69	80	62	59	66	50
September	60	74	49	63	74	57	67	78	60	62	76	54	60	72	48
October	52	63	40	56	64	50	53	62	44	57	64	44	48	54	40
November	47	56	38	51	57	40	43	54	32	48	58	40	39	58	30
December	46	55	38	39	53	26	39	46	26	44	54	34	39	58	30

	1783.			1784.			1783.			1786.			1787.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	40	48	28	32	44	26	37	48	28	39	50	22	39	52	30
February	42	50	32	35	48	32	34	44	26	37	48	30	46	50	34
March	42	52	32	40	48	32	37	46	30	39	53	28	46	56	38
April	56	68	44	45	56	34	53	68	38	51	62	38	47	56	40
May	54	66	44	59	76	48	57	86	55	68	44	55	55	60	40
June	61	72	52	57	68	52	66	86	50	66	80	54	56	66	52
July	66	80	58	62	74	54	65	76	54	62	70	50	57	70	48
August	64	76	52	60	72	54	58	70	50	62	72	54	57	74	52
September	58	66	52	62	76	52	57	70	55	65	65	48	56	66	50
October	52	62	42	49	58	44	51	62	36	48	62	36	51	60	42
November	44	52	32	42	50	34	44	54	38	39	48	32	45	58	35
December	34	48	24	32	46	26	36	46	30	40	48	28	41	57	31

	1788.			1789.			1790.			1791.			1792.		
	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.	M.	H.	L.
January	42	50	36	38	54	22	42	52	35	42	53	30	50	28	
February	41	48	31	44	52	39	48	54	40	44	54	36	44	54	33
March	41	59	30	42	47	33	48	57	41	49	58	39	47	55	37
April	52	70	44	50	58	43	48	55	42	53	67	43	54	68	43
May	65	81	43	58	68	45	54	66	46	56	76	43	55	61	47
June	66	85	59	59	76	52	61	75	50	64	86	54	60	71	53
July	64	71	57	63	73	53	62	70	53	61	77	54	63	70	57
August	65	74	59	67	78	61	63	72	53	63	73	47	64	78	59
September	61	71	48	60	68	52	55	65	49	61	78	46	57	68	51
October	53	61	45	50	57	41	52	65	45	52	65	47	52	64	43
November	45	57	33	44	50	35	45	54	33	45	54	42	49	59	40
December	33	44	25	46	53	39	42	50	32	38	50	32	45	53	33

Mean annual height and range of the Thermometer in each of the preceding years.

Years.	Mean.	Hight.	Lowest.	Range.	Years.	Mean.	Hight.	Lowest.	Range.	Years.	Mean.	Hight.	Lowest.	Range.
1768	55	71	29	42	1776	56	73	34	39	1785	49	86	26	60
1769	56	78	42	36	1777	53	79	31	48	1786	49	72	22	50
1770	48	57	37	20	1778	53	80	31	49	1787	49	74	30	44
1771	55	74	40	34	1779	57	88	26	62	1788	52	85	25	60
1772	55	75	38	37	1780	52	84	24	60	1789	51	78	22	56
1773	57	76	42	34	1781	55	84	24	60	1790	51	75	32	43
1774	56	72	40	32	1782	49	78	30	48	1791	52	86	32	54
1775	58	76	44	32	1783	51	80	24	60	1792	51	78	28	50
					1784	47	76	26	50					

Hence it appears, that the mean heat at Liverpool at twelve o'clock, deduced from an average of twenty-five years, is 53° of Fahrenheit's Thermometer: the greatest degree of heat during that period 86° ; the least 22° : the greatest range 64° ; and the mean annual range 46° .

Mean height of the Thermometer at Liverpool in each month on an average of twenty-five years.

February	44	May	58	August	65	November	47
March	47	June	63	September	61	December	43
April	52	July	65	October	54	January	41
Mean heat of the Spring	48	Mean heat of Summer	62	Mean heat of Autumn	60	Mean heat of Winter.	44

*Observations on the Thermometer at Dover, abstracted from Mr. MANTELL'S
Journal.*

	1789.	1790.	1791	1792.	1793.										
	Mean.	Highest.	Lowest.	M.	H.	L.									
January				36	45	28	36	47	26	32	44	17	32	40	25
February				39	49	29	34	43	27	33	44	16	36	41	30
March				39	48	34	37	46	26	37	49	22	37	44	37
April				38	50	32	44	54	37	44	56	34	39	47	30
May				50	69	42	46	53	34	45	54	37	45	54	40
June				55	86	46	53	86	47	51	71	45	51	70	42
July				56	69	49	55	67	48	56	66	50	61	77	50
August				57	74	47	58	72	47	61	78	51	62	76	53
September				50	61	44	55	66	44	50	63	40	51	66	41
October	45	57	33	48	60	35	45	55	35	46	54	37			
November	37	47	27	39	50	28	39	44	28	40	49	28			
December	39	46	28	36	50	26	31	43	26	36	47	27			

Mean annual height and range of the Thermometer at Dover for the preceding years.

Years.	Mean.	Highest.	Lowest.	Range.
1789	40	57	27	30
1790	45	86	26	60
1791	44	76	26	50
1792	44	78	16	62
1793	46	77	25	52

From this it would appear, that the mean heat at Dover is 53° : the greatest degree of heat noticed in the observations for the preceding years 86° ; the least 16: the greatest range 70° ; and the mean annual range 51° nearly.

The mean here is however lower than the truth, owing to the observations of the first and last years not being complete.

If we take the three complete years, viz. 1790, 1791, and 1792, the means will stand thus.

Annual mean 44° .

Annual range 57.

I cannot, however, but suspect that the mean annual heat at Dover, will be found greater than it is given by calculation from these observations.

The observations were taken three times a day, at eight o'clock A. M. at four and ten P. M.

P. M. In all probability, if the middle observation had been taken at two o'clock P. M. the mean degree of heat would have been about 48° . or 49° . or, according to Mr. Kirwan's Theorem, 50° .

Mean height of the Thermometer in each Month, at
Dover.

February	36	May	48	August	59	Nov.	39
March	37	June	52	Septemb.	51	Dec.	35
April	41	July	57	October	46	January	34
Mean heat of the Spring	38	Mean heat of Summer	52	Mean Autumnal heat	52	Mean heat of Winter	36

Mean

Observations on the Thermometer at Middletown. From Mr. VERNON'S Journal.

The Thermometer was placed in a room facing the North East, where no fires were kept; and the remarks were made about ten o'clock in the morning.

	1768.				1769.				1770.				1771.				1772.			
	Mean	Highest	Lowest	Range	M.	H.	L.	R.	M.	H.	L.	R.	M.	H.	L.	R.	M.	H.	L.	R.
January	35	46	23	23	36	45	32	13	42	48	30	18	37	50	28	22	35	40	31	9
February	44	52	35	17	40	47	38	9	43	50	34	16	39	50	28	22	37	46	21	25
March	45	50	38	12	47	50	43	7	41	49	36	13	40	49	34	15	44	50	34	10
April	53	58	48	10	53	66	45	21	48	55	43	12	47	52	39	13	50	55	41	14
May	66	74	49	25	60	67	51	16	58	66	44	22	61	67	48	19	56	62	49	13
June	66	74	56	17	63	67	58	9	62	65	56	9	65	76	56	20	68	76	54	22
July	68	74	65	9	70	78	64	14	65	74	57	17	66	75	62	13	69	76	66	10
August	67	73	62	11	65	70	61	9	Not observed				64	69	58	11	66	70	63	7
September	58	65	53	12	60	64	55	9	65	70	59	11	59	64	54	10	60	66	52	14
October	53	60	47	13	51	56	48	8	51	60	40	20	51	60	44	16	56	61	48	13
November	45	49	38	11	45	47	36	11	44	50	34	16	45	52	37	15	47	54	38	16
December	42	48	34	14	42	50	34	16	40	46	31	15	42	49	34	15	42	50	34	16

Mean annual heat, and range of, the Thermometer in each of the preceding years.

Years	Mean	Highest	Lowest	Range
1768	53	74	23	51
1769	53	78	32	46
1770	51	74	30	44
1771	51	76	28	48
1772	52	76	21	55

The mean heat at Middlewich appears from hence, to be 52°. from an average of five years. The greatest heat during that period was 78°. The least 21: The greatest range 57; and the mean annual range 49.—It must be remembered, however, that the Thermometer was not exposed to the open air, but kept in a room facing the North East, in which there was no fire.

Mean height of the Thermometer at Middlewich, in each month, on an average of five years.

February	40	May	60
March	43	June	65
April	50	July	68
Mean heat of the Spring.	44	Mean heat of Summer.	64

August

August	65	November	45
September	60	December	42
October	52	January	37
Mean heat of Autumn.	60	Mean heat of Winter.	41

Observations on the Thermometer at Kendal, by Mr.
J. GOUGH. Continued from p. 258.

	1792.	1793.	1794.
	Mean height of the Thermome- ter.	Mean heat.	Mean heat.
January		35,03	35,204
February		38,41	42,809
March		37,43	42,540
April		42,31	47,655
May		52,69	51,392
June		55,91	61,511
July		62,43	63,903
August	60,59	57,81	57,215
September	50,57	51,88	52,900
October	46,30	51,34	47,263
November	43,49	41,59	41,020
December	38,35	40,60	38,204

Mr. Gough says, that “ the observations
“ from which these means are deduced, were
“ taken three times a day. The annual mean
“ temperature, found in this manner, agrees
“ very well with the temperature of our best
“ springs, which is nearly invariable. Now,
“ according to Kirwan’s estimate, the mean
“ heat of the ocean in latitude $54^{\circ}, 5'$ is
“ nearly 48,8 of Fahrenheit’s scale; and sup-
“ posing, what is near the truth, the eleva-
“ tion of the town and its distance from the
“ ocean to be sixty yards and twenty-five
“ miles respectively, the greatest correction we
“ are authorized to make, by the rules laid
“ down in the fifth Chapter of Mr. Kirwan’s
“ work, reduces it to 48,20. which exceeds
“ the mean drawn from actual observation by
“ one degree at least: a difference that can
“ only be attributed to the influence of the
“ extensive chain of hills which incumbers this
“ part of England; and which has, un-
“ doubtedly, a very sensible effect on the tem-
“ perature, as well as the other properties of
“ the weather.”

*Observations on the Thermometer at Dumfries, by
MR. ALEX. COPLAND, continued from p. 272.*

1793.				
	Medium for each month,	Above the medium.	Below the medium.	Medium of each month for six years.
January	38,0622	2,2204		35,8418
February	43,4687	2,6732		40,7955
March	41,9241		1,7409	43,6650
April	48,8540		,8677	49,7217
May	57,3750		,5064	57,8814
June	60,5000		2,4007	62,9007
July	68,9820	2,628		66,3540
August	63,5072		1,9900	65,4972
September	56,9220		1,1030	58,0250
October	55,0312	4,8946		50,1366
November	43,0240	1,1644		41,8596
December	42,3527	4,4231		37,9296
Annual mean.	51,6669	9,3950		50,8840

Medium heat in each Season.

1793.	Medium 1793.	Above the medium.	Below the medium.	Medium for six preceding years.
Spring	44,7489	,0215		44,7274
Summer	62,2857		,0926	62,3783
Autumn	58,4868	,6005		57,8863
Winter	41,1463	2,6027		38,5436

Observations on the Thermometer at Keswick, in 1793, by MR. PETER CROSTHWAITE. Continued from p. 28. of Mr. Dalton's Observations.

1793	Mean.	Highest.	Lowest	Range.
January	37	48	23	25
February	41	50	30	20
March	41	50	32	18
April	42	55	26	29
May	50	64	39	25
June	54	63	46	17
July	63	84	51	33
August	57	69	52	17
September	51	63	42	21
October	51	59	33	26
November	41	56	27	29
December	40	50	29	21

Observations on the Thermometer at York, from DR. WHITE'S Journal.

	1771	1772	1773	1774		
	Mean Height			Mean.	Highest.	Lowest.
January	36	23	35	27	39	15
February	30	29	29	39	56	23
March	35	37	49	44	58	31
April	40	41	57	54	68	40
May	51	Broken	70	64	85	43
June	53	—	78	68	87	49
July	56	—	81	75	98	52
August	54	—	75	75	96	54
September	52	—	58	62	80	45
October	48	—	47	50	60	41
November	42	45	37	40	48	32
December	38	48	34	30	39	21

Observations

*Observations on the Thermometer at York, in the year
1794, by the REV. MR. WELLBE.*

The observations were made at eight o'clock
A. M. and P. M.

1793	Mean.	Highest.	Lowest.
January	34	37	21
February	44	54	37
March	43	54	33
April	49	63	39
May	51	64	40
June	55	69	44
July	60	67	53*
August	58	67	50
September	53	63	43
October	47	59	37
November	42	53	33
December	38	55	27

It would appear, from Dr. White's and Mr. Wellbe's observations, that the mean annual heat at York is 49°.

* During the months June and July, owing to Mr. W's absence, the diary was interrupted.

The

The medium heat of each season, deduced from the same observations, is as follows.

February	35	May	59
March	43	June	63
April	50	July	68
Mean heat of Spring	$42\frac{2}{3}$	Mean heat of Summer	$63\frac{1}{3}$

August	65	Nov.	40
Septemb.	56	Dec.	35
October	48	January	33
Mean heat of Autumn	$56\frac{1}{3}$	Mean heat of Winter	36

Some Observations on the Thermometer at Manchester,
by MR. GEORGE WALKER.

March 9th. 1786, at 8 A. M. the Thermometer
was at - - - 16°.

Jan. 28th. 1787, 8 A. M. - - - 30.

Aug. 7th. —, noon - - - 74.

March 8th. 1788, 8 A. M. - - - 19.

May 25th. —, 4 P. M. - - - $78\frac{1}{2}$.

Sept. 11th. 1791, 2 P. M. - - - 74.

— In the sunshine 130°. The
instrument, in this instance, was placed perpen-
dicularly

dicularly to the solar rays, and had a metallic scale.

Jan. 12th. 1792, at 8 A. M.	- - -	19.
Aug. 8th. —, 3 P. M.	- - -	74.
1793. Lowest	- - -	28.
Hight	- - -	78.

As the preceding observations were made, I believe, with common mercurial thermometers, the mean annual heat of each place cannot be determined accurately from them. As the greatest degree of cold within the twenty-four hours, which occurs about half an hour before sun-rise, has seldom been observed, the mean heat deduced from these observations, will be some degrees higher than the true mean.—The best thermometers for observations of this nature, are those invented by Mr. Six, which point out the greatest and least degrees of heat in the observer's absence.

The following account of very great degrees of cold, which were observed at Chatham in January 1776, with the height of the barometer and direction of the winds at that time, with some other observations, was communicated to me by Dr. Percival.

Height

Height of the Thermometer.—Fahrenheit's Scale.

Height of the Thermometer. — Fahrenheit's Scale.																											
Ante Meridiem.												Post Meridiem.															
Hours	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
Sat. 20														28		25		17	9	8½	9	11	14				
Friday 26													23		21	20	20	19		18	16½						
Saturday 27								17					17½					15	14	14	14						
Sunday 28								14	16				17		15		13	12	11	10	10½	11					
Monday 29								7					23				15		8½	10	11	9½					
Tuesday 30								10		11		17		19½		19		12	11	7	4½	3½	1	½			
Wednesd. 31	1	1				0 3½	0 3½	0 3½	0	6	11	17	22	22½	20	14	10	5	3	1	0	0 1	0 1½				
Thur. Feb. 1							4	6	12		25	29		32													
Thermometer not higher than												Height of the Barometer at two o'clock P. M.												Wind at two o'clock P. M.			
												29,72												NNW.			
												29,84												E.			
												29,81												E.			
												18												E.			
												30,04												E.			
												24												E.			
												29,92												E.			
												21												E.			
												30,07												E.			
												23												Calm			
												30,10												Calm			
												29,91												S.			

On January 13, 14, 15, there fell so much snow, that the great turnpike road between London and Dover, was utterly impassable even for horsemen, for several days. On the 28th. the river Medway (the water of which is salt) was frozen over, from Rochester bridge to Gillingham. Many hundreds of persons walked from one shore to the other; and butts of water were rolled over the ice from the King's dock yard, to the men of war in the harbour. The breath of many was condensed and frozen to the sheets near their mouths in bed, in chambers, which at every other time would be called warm rooms.—January 29, 30, 31, were clear days, not one cloud was seen. A Thermometer was constantly exposed to the sun, which at no time was able to raise the mercury higher than one degree above the freezing point; but the greatest part of the day not so high by many divisions. Two Thermometers (made by Nairne) were used in the above observations. They are very good ones, being graduated according to the bores of the tubes: they not only correspond with each other, but also with others of the best sort. These observations were made in a garden near the market-place, by Mr. Simmons, surgeon; who, when the thermometer had fallen to four, which was the greatest degree of natural cold he re-

membered to have observed in England, hardly crediting the evidence of his eyes, immediately procured the concurrent testimony of two curious and intelligent friends, who were also eye witnesses to the still more astonishing degrees which succeeded.—Where there are blank spaces in the table, no observations were made. Below nought is signified by an o over the figures.

§ III. OF RAIN.

Observations on the quantity of Rain which fell at Liverpool, with the number of wet and variable days in each month, for a period of eighteen years, beginning with the year 1775. Abstracted from MR. HUTCHINSON'S Journal.

When rain is mentioned both in the morning and evening observations of Mr. Hutchinson's Journal, unless it is observed to be but little, I have called the day wet; and where rain occurs in the morning, or evening observation only, unless it is observed to be heavy, I have called the day variable.—The height of the rain was given in inches and eighths, and fractions of eighths, which, for the convenience of comparison, I have reduced to decimals,

	1775.			1776.		
	Inches of rain.	Wet days.	Variable.	Inches of rain.	Wet days.	Variable.
January	1,1296	6	13	1,5624	9	9
February	2,6250	5	14	4,2500	11	11
March	1,5351	6	10	1,8750	5	13
April	0,5632	2	9	1,0624	5	8
May	0,6891	1	9	1,1874	4	15
June	2,2812	3	11	3,0000	7	13
July	4,9648	9	14	3,8124	7	15
August	3,3437	9	12	3,5624	11	16
September	3,0000	4	12	5,2186	9	19
October	4,3750	10	15	2,2186	4	9
November	2,8437	9	6	2,9062	9	7
December	2,3281	5	14	2,5312	6	13

	1777.			1778.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	1,8750	2	12	2,0312	8	10
February	2,2500	8	11	1,0624	4	10
March	2,1250	7	8	1,8436	8	11
April	1,9062	6	8	1,7186	8	12
May	2,8124	6	13	2,4686	5	17
June	2,2500	6	14	4,1250	6	15
July	2,4374	6	9	5,5000	7	13
August	3,2186	9	11	0,7186	1	8
September	2,2186	5	9	2,0936	2	18
October	4,1250	9	10	5,2500	9	8
November	3,3436	9	12	4,8436	12	11
December	1,6250	5	9	3,9686	12	8

	1779.			1780.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	0,1874	0	4	1,1250	3	11
February	0,4374	1	7	3,0936	3	13
March	0,5000	1	7	1,3124	2	16
April	1,1874	7	13	1,8124	9	14
May	2,3124	7	13	1,5624	5	15
June	2,2500	4	9	1,3436	4	10
July	4,0936	5	8	1,8436	5	10
August	0,7812	1	7	0,4374	1	5
September	3,4374	8	17	4,6562	10	14
October	2,5936	10	9	3,9062	8	14
November	3,0936	8	12	3,5312	8	14
December	5,6562	11	13	0,2186	2	6

	1781.			1782.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	2,0000	7	5	2,3750	5	13
February	3,3750	9	9	0,7500	4	10
March	0,4686	0	7	1,8124	6	14
April	2,4062	3	10	4,0312	11	13
May	2,2812	3	6	3,9062	7	16
June	4,0936	8	7	1,2186	3	12
July	1,5936	2	8	1,9686	3	16
August	4,4686	10	9	6,5624	8	15
September	2,7500	6	11	3,1250	4	13
October	1,0000	1	16	2,8124	9	9
November	4,7812	11	8	2,4062	6	9
December	1,9686	5	10	1,9374	3	10

	1783.			1784.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	4,1874	9	12	2,8436	4	11
February	2,9062	10	10	1,1250	5	10
March	2,3436	5	8	1,5624	3	14
April	0,5000	0	7	3,3124	8	15
May	3,2500	3	12	1,6874	2	8
June	3,3436	5	7	4,2812	8	10
July	3,1874	5	9	2,8436	4	8
August	6,0936	8	13	3,6874	5	11
September	4,7812	9	9	1,8436	2	6
October	3,0312	6	10	0,7500	1	8
November	3,5312	6	8	3,3124	9	9
December	1,4062	2	11	3,0312	4	11

	1785.			1786.		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	2,2500	6	8	2,4686	6	14
February	1,0624	3	12	0,8750	4	9
March	0,8124	2	11	0,8750	5	9
April	0,6562	4	3	0,7186	2	9
May	1,0936	2	9	3,0624	2	14
June	1,3436	1	6	2,1250	5	9
July	1,6874	3	11	1,6874	6	9
August	4,5936	6	15	3,1874	8	16
September	3,2812	5	17	4,5624	13	8
October	3,4062	10	9	1,5624	3	11
November	3,3750	9	4	2,1874	5	9
December	2,0624	5	14	3,0312	5	12

	1787			1788		
	Rain.	Wet.	Vari- able.	Rain.	Wet.	Vari- able.
January	0,8750	4	6	1,8812	2	12
February	1,8436	6	15	2,4686	7	9
March	2,2186	8	8	2,2812	6	6
April	1,0936	4	11	1,8124	7	9
May	1,4062	1	10	1,6250	3	7
June	2,4062	5	11	1,4374	1	9
July	5,5624	9	12	4,2186	7	20
August	3,2812	4	13	2,0936	5	10
September	1,6250	2	9	2,6874	6	14
October	9,1562	12	12	2,3124	6	8
November	3,8436	8	10	1,3436	2	5
December	4,7500	8	13	0,4374	4	7

	1789			1790		
	Rain.	Wet.	Vari- able.	Rain.	Wet.	Vari- able.
January	1,3750	4	13	3,9062	5	14
February	1,5000	5	11	1,0000	1	8
March	0,6562	4	11	1,2186	1	3*
April	2,0312	3	14	1,9686	2	10
May	4,5000	4	14	4,6562	4	16
June	7,6562	9	13	3,0936	7	10
July	6,5000	8	18	5,4686	5	15
August	1,7186	0	9	3,5312	4	14†
September	5,8124	7	15	3,2500	5	12
October	7,7500	9	10	2,5312	3	8
November	4,1874	5	11	4,7812	7	8
December	5,0000	5	15	7,1562	8	11

1791

* March 1790, there were six days on which no observation was taken.

† No observation was taken for the same number of days in August 1790.

	1791			1792		
	Rain.	Wet.	Variable.	Rain.	Wet.	Variable.
January	4,3124	4	14	2,7500	4	11
February	2,3750	5	12	2,2500	4	11
March	1,4374	2	6	2,5312	4	17
April	4,5624	6	14	6,5312	7	7
May	1,5000	2	10	6,3124	12	8
June	1,8750	3	12	2,5624	7	9
July	4,7812	6	12	3,7812	5	12
August	4,1250	6	10	6,1874	7	10
September	3,4374	2	7	8,0000	14	12
October	5,8436	11	6	4,4062	7	14
November	5,4062	7	15	2,2186	5	4
December	5,7500	10	10	6,7186	8	15

Mean quantity of rain in each of the preceding years at Liverpool.

1775	29,6785	1781	31,1866	1787	38,0616
1776	33,1866	1782	32,9054	1788	25,5988
1777	30,1768	1783	38,5616	1789	48,6870
1778	35,6238	1784	30,2802	1790	42,5616
1779	26,5302	1785	25,6240	1791	45,4056
1780	24,8426	1786	26,3428	1792	54,2492

Hence it appears, that the mean annual quantity of rain which falls at Liverpool, deduced from an average of 18 years, is 34,4168 inches.

Mr.

Mr. Hutchinson's rain gage was placed at the top of his house, 41 feet above the highest water-mark.

Mean falls of rain at Liverpool in each month, and each season of the year—from an average of eighteen years.

February	1,8471	May	2,5729
March	1,5227	June	2,8159
April	2,1041	July	3,6628
Mean falls in the Spring.	5,4739	Mean falls in Summer.	9,0516

August	3,3106	November	3,4408
September	3,6544	December	3,2876
October	3,7239	January	2,1741
Mean falls in Autumn	10,6889	Mean falls in Winter	8,9025

Mr. Hutchinson did not begin his observations on the quantity of rain till the year 1775.—I shall therefore insert the number of wet and variable days, extracted from his journal previous to that period.

	1768	1769	1770	1771	1772	1773	1774	
	Wet.	Vari- able.	W.	V.	W.	V.	W.	V.
January	3	14	5	9	12	9	7	8
February	6	10	8	6	5	7	11	10
March	1	6	7	6	4	10	1	5
April	8	7	8	6	9	4	10	11
May	4	8	5	8	6	8	13	6
June	7	7	13	6	3	10	5	11
July	10	9	5	9	10	4	6	6
August	5	10	8	14	8	12	8	9
September	8	9	11	7	15	12	8	5
October	7	6	7	4	11	7	11	8
November	11	6	10	7	8	16	8	10
December	11	5	7	9	7	3	9	7

Observations on the quantity of Rain at Dover, with the number of days on which there was rain or snow. From Mr. MANTELL'S Journal.

As Mr. Mantell has only marked the days "rain" or "fair," the days on which there was rain could not be divided into wet and variable.

	1789	1790	1791	1792	1793				
	Rain.	Rainy days.	Rain.	Rainy days.	Rain.	Rainy days.			
January		3,03	11	7,07	20	6,03	13	3,41	12
February		2,71	7	4,71	11	2,70	8	3,90	13
March		0,32	3	0,76	3	6,33	17	4,98	11
April		2,63	12	3,90	9	3,75	8	1,62	10
May		1,91	10	4,81	10	3,45	12	3,44	11
June		1,06	8	1,61	8	3,41	10	2,98	8
July		6,51	15	4,43	17	4,56	12	3,84	9
August		2,60	7	2,78	7	3,88	9	2,43	8
September		3,34	10	1,05	5	4,87	16	5,10	13
October	7,31	3,49	9	3,54	10	5,71	11		
November	5,19	5,05	10	5,52	16	2,38	8		
December	3,80	10,71	18	4,70	16	4,33	12		

Mean quantity of rain at Dover, in each of the preceding years.

1789	16,30
1790	43,36
1791	44,88
1792	51,40
1793	31,70

Mean annual falls 37,52 inches.

Observations on the Falls of Rain at Kendal and Waith-Sutton, by MR. GOUGH. Continued from p. 258.

	Kendal.			Waith-Sutton.	
	1792	1793	1794	1792	1793
January		6,3690	7,2984		3,41
February		8,0916	13,4724		5,29
March		4,5696	4,5304		3,26
April		1,5642	4,1808		1,30
May		1,8798	1,9998		1,81
June		3,3498	1,4574		2,95
July		3,5898	4,1604		3,75
August	7,2120	6,6798	5,3400	6,41	6,48
September	10,8348	2,4006	7,6746	9,00	2,54
October	5,7768	5,3526	7,3296	5,10	5,35
November	5,7414	3,6102	6,0114	4,24	3,84
December	12,688	7,2396	6,2040	10,15	4,87
	C c c c 2			Rain	

Rain at Dumfries, in the year 1793, by MR. ALEX.
COPLAND. Continued from p. 272.

Rain Gage one foot square.

1793.

	Quantity of falls.	Correspond- ing depth.	Above the medium.	Below the medium.	Medium of each month for 16 years
	lb. oz. dr.	Inches.	Inches.	Inches.	Inches.
Jan.	11, 0, 3	2, 21 11		, 88 38	3, 09 49
Feb.	29, 2, 4	5, 8 39 5	3, 00 2		2, 8 37 5
Mar.	20, 15, 6	4, 20 7 8	2, 04 3 6		2, 16 4 2
Apr.	4, 7, 6	, 96 8 6		1, 04 8 3	2, 01 6 9
May	10, 10, 4	2, 13 6 8		, 43 1 3	2, 56 8 1
June	13, 15, 6	2, 80 4 1		, 170	2, 97 4 1
July	6, 12, 3	1, 35 8 2		1, 89 7 8	3, 25 6 0
Aug.	20, 5, 3 $\frac{1}{2}$	4, 06 6 0	, 86 6 8		3, 19 9 2
Sep.	7, 4, 4 $\frac{1}{2}$	1, 46 0 8		2, 88 9 0	4, 34 9 8
Oct.	12, 7, 5	2, 50 1 8		1, 64 1 6	4, 14 3 4
Nov.	12, 15, 1 $\frac{1}{2}$	2, 59 6 6		, 55 7 0	3, 17 3 6
Dec.	19, 6, 7	3, 88 8 3	, 74 6 8		3, 14 1 5
Total	170, 15 $\frac{1}{2}$	34, 03 9 6		2, 89 9 6	36, 93 9 2

Medium of the falls at Dumfries, in each season
of the year 1793.

	Mean in each season.	Above the medium.	Below the medium.	Medium for the 16 pre- ceding years.
Spring	11, 01 5 9	3, 99 7 3		7, 01 8 6
Summer	6, 29 9 1		2, 49 9 1	8, 79 8 2
Autumn	8, 02 8 6		3, 66 3 8	11, 69 2 4
Winter	8, 69 6 0		, 71 4	9, 41 0 0

Falls

Falls of Rain at Kirkmichael, about eight miles North by East of Dumfries, near the bottom of high mountains, from the year 1773 to 1776 inclusive, by the REV. DR. BURGESS. Communicated by MR. COPLAND,

Mr. Copland remarks, that “ the following observations (being for a period of near twenty years distant from his, and being made by one, whose accuracy and abilities for such an undertaking are incontrovertible) are well calculated to answer the purpose for which these statements are designed,”

Mean depth of falls in each month of 1773, 1774, 1775, and 1776.

January	February	March	April	May	June
3,133	4,612	2,040	3,387	,902	2,698
July	August	Sept.	Oct.	Nov.	Dec.
4,800	3,917	5,348	4,725	3,512	2,706

Annual mean 40,780 inches.

Falls

*Falls of Rain at Kefwick, by Mr. CROSTHWAITE,
Continued from p. 38 of Mr. DALTON's Effays.*

	1793	1794
January	5,7131	5,7091
February	9,6491	11,1686
March	5,3214	6,4370
April	1,7878	5,3981
May	1,8430	3,2625
June	4,6404	1,6340
July	2,6400	2,5674
August	8,8483	3,1317
September	2,8825	8,1209
October	6,2219	9,4431
November	3,4090	6,8913
December	7,3448	8,0030

Rain at Garsdale, by Mr. THOMAS BLADES.

Garsdale lies N. E. of Kendal, at the distance of about thirteen miles. It is a narrow valley, some miles long, with very high hills on each side.

	1777		1778		1779	
	Rain.	Rainy Days.	Rain.	Rainy Days.	Rain.	Rainy Days.
January	2,2671	15	4,2380	21	1,5036	14
February	3,7507	16	1,9533	16	2,3802	14
March	3,9694	21	5,1516	24	1,4514	11
April	3,9848	13	2,6647	21	3,8320	20
May	2,2962	17	7,3690	23	4,7945	22
June	5,3209	19	3,3222	19	2,048	9
July	3,3704	17	7,6976	21	5,0178	17
August	5,6079	21	5,1213	15	1,0931	12
September	2,2937	16	4,1859	19	7,5633	27
October	6,9006	23	4,8353	20	8,7239	17
November	9,6546	25	5,7772	22	4,3384	17
December	3,1127	19	9,0499	28	3,2220	17
	49,5290	222	61,3660	249	45,9991	197

Account

Account of the Rain at Manchester, by Mr. GEORGE WALKER.
Communicated by Dr. PERCIVAL.

	1783	1784	1785	1786	1787	1788	
	Rain or Snow days.	Rain or Snow days.	Rain or Snow days.	Rain or Snow days.	Depth of Rain Inches L.	Rain or Snow days.	Depth of Rain L. L.
January	24	11	12	21	2,6	15	1,9
February	26	19	17	15	1,6	18	1,8
March	22	14	14	18	2,2	17	2,6
April	5	23	8	4	,11	10	1,10
May	8	12	11	21	3,6	10	1,10
June	15	27	11	12	4,0	13	1,0
July	14	19	16	20	2,8	26	4,10
August	20	18	22	25	6,6	20	3,9
September	12	8	23	22	7,10	13	2,0
October	12	7	23	13	2,9	21	2,10
November	4	17	15	12	1,5	14	2,4
December	21	13	21	24	4,8	23	1,0
	183	188	193	207	40,5	230	27,4

	1789	1790	1791	1792	1793					
	Rain or snow days.	Depth of Rain. I. L.	Rain or snow days.	Depth of Rain. I. L.	Rain or snow days.	Depth of Rain. I. L.				
January	21	2,0	21	2,3	29	5,6	19	2,0	22	2,75
February	24	5,4	11	1,3	23	3,0	16	2,0	26	3,75
March	23	1,6	6	1,0	12	1,6	24	2,9	25	2,5
April	21	2,8	11	2,3	22	4,9	16	2,6	14	1,75
May	20	4,6	24	3,3	19	2,9	26	8,0	9	1,5
June	22	6,6	19	5,6	8	0,9	24	3,6	20	2,65
July	31	7,3	23	5,9	22	3,6	24	3,9	11	1,25
August	11	0,10	24	4,6	19	6,0	18	6,3	20	6,5
September	20	4,3	19	3,9	11	1,5	26	9,0	23	3,3
October	23	5,9	14	2,9	23	4,6	17	4,0	21	4,5
November	22	4,9	15	3,3	25	4,6	12	2,0	18	2,5
December	25	5,8	23	7,3	20	5,10	26	9,6	24	3,55
	263	51	210	42½	233	44	248	55½	233	36½

The town of Manchester is situated about forty miles east of the sea. The surface of the river Irwell is about sixty-three feet above low water mark at Liverpool.

State of the falls of Rain, &c. at Chalfworth, in Derbyshire. Communicated to Dr. PERCIVAL by LORD GEORGE CAVENDISH.

State of the perpendicular height of the Falls of Rain, &c. during the seven years preceding 1784.

	1777	1778	1779	1780	1781	1782	1783	Total in the same month of each year.
January	0,834	2,704	0,693	1,270	1,439	3,017	3,017	12,974
February	1,739	1,252	0,241	1,213	3,450	1,037	2,782	11,714
March	1,701	1,122	0,480	1,216	0,117	1,987	2,263	18,886
April	2,304	1,326	2,162	3,888	1,901	6,960	0,539	19,080
May	1,544	2,218	1,485	1,531	1,575	4,659	2,988	16,000
June	1,774	0,586	2,045	1,088	2,083	2,815	3,221	13,612
July	3,189	3,552	4,810	1,010	1,410	3,640	1,527	19,138
August	2,292	0,809	0,652	0,335	2,578	4,813	2,757	14,236
September	1,223	1,817	3,030	3,276	2,597	4,451	5,816	22,210
October	5,019	6,377	3,298	4,093	0,109	2,287	1,832	23,015
November	1,741	2,991	1,689	1,281	3,614	1,557	2,412	15,285
December	1,434	5,141	3,977	0,240	2,172	1,893	0,372	15,229
Total in each year	24,794	29,895	24,562	20,441	23,045	39,116	29,526	191,379

The average of the annual falls, for the seven years commencing with 1777, is 27,339 inches.

The average falls in each month, during seven years commencing with 1777, classed according to the seasons.

SPRING.		SUMMER.	
February	1,673	May	2,285
March	1,269	June	1,944
April	2,725	July	2,734
Mean falls in Spring.	5,667	Mean falls in Summer.	6,963

AUTUMN.		WINTER.	
August	2,033	November	2,183
September	3,173	December	2,175
October	3,288	January	1,853
Mean falls in Autumn.	8,494	Mean falls in Winter.	6,211

State of the perpendicular height of the falls of rain, &c. at Chalforth,
during the seven years preceding 1791.

	1784	1785	1786	1787	1788	1789	1790	Total in the same month of each year.
January	2,439	1,136	3,607	0,652	1,723	2,118	50	13,925
February	1,410	0,374	1,104	2,130	2,532	3,616	0,461	11,627
March	1,206	0,786	1,164	3,556	1,438	1,120	0,513	9,783
April	2,388	0,122	0,883	1,174	1,078	2,206	0,512	8,363
May	1,882	0,863	2,804	1,569	1,725	2,379	2,778	14,000
June	4,020	1,121	1,910	1,375	2,756	4,851	2,963	18,996
July	3,552	2,438	1,211	6,166	2,332	5,617	2,620	23,936
August	1,938	4,022	3,927	2,547	2,145	1,201	2,468	18,248
September	1,047	2,767	3,910	1,823	1,724	3,582	2,556	17,409
October	0,455	3,710	3,067	4,290	1,693	4,483	1,732	19,430
November	2,257	2,718	3,877	3,279	0,597	2,443	3,748	18,919
December	0,382	3,105	3,212	3,507	0,113	2,693	4,291	17,303
Total in each Year.	22,976	23,162	30,676	32,068	19,856	36,309	26,892	161,939

The average of the annual falls, for the seven years commencing with 1774,
is 27,419 inches.

The average falls in each month, during the seven years commencing with 1784, classed according to the seasons.

SPRING.		SUMMER.	
February	1,661	May	2,000
March	1,397	June	2,713
April	1,194	July	3,419
Mean falls in Spring	4,252	Mean falls in Summer.	8,132

AUTUMN.		WINTER.	
August	2,606	November	2,702
September	2,487	December	2,471
October	2,775	January	1,989
Mean falls in Autumn	7,868	Mean falls in Winter	7,162

The average of falls in each season, for fourteen years preceding 1791, is as under :

Spring	-	4,959
Summer	-	7,547
Autumn	-	8,181
Winter	-	6,686,

State of the perpendicular height of the falls of rain at Chatsworth, in the years 1791, 1792, and to the month of August, 1793.

	1791	1792	1793
January	6,373	1,870	1,926
February	2,061	1,042	1,616
March	0,707	1,783	2,306
April	2,511	3,309	2,536
May	0,779	3,121	0,749
June	1,023	2,961	0,773
July	2,508	2,525	0,657
August	3,665	2,822	
September	2,506	4,508	
October	3,333	3,487	
November	5,951	2,003	
December	3,281	5,309	
Total in each year.	34,698	34,740	

Amount of the falls in each season throughout the year 1791, compared with the medium during the preceding fourteen years, during the same seasons.

	Depth of falls.	Above the medium.	Below the medium.	Medium for 14 years.
Spring	5,279	,320		4,959
Summer	4,310		3,237	7,547
Autumn	9,504	1,323		8,181
Winter	15,605	8,919		6,686
Throughout the year.	34,698	10,562	3,237	27,373

Amount

Amount of the falls in each season throughout the year 1792, compared with the medium for the preceding fifteen years during the same seasons.

	Depth of falls.	Above the medium.	Below the medium.	Medium for 15 years.
Spring	6,134	1,153		4,981
Summer	8,607	1,276		7,331
Autumn	10,817	2,547		8,270
Winter	9,182	1,899		7,283
Throughout the year.	34,740	6,875		27,865

Account of the perpendicular height of the Rain that has fallen at Lancaster, by DR. CAMPBELL. Continued from p. 365.

	1791		1792		1793	
	In.	Lines	In.	L.	In.	L.
January	5	10	3	2	4	6
February	3	1 $\frac{3}{4}$	3	0	3	8 $\frac{1}{2}$
March	2	2	5	9	2	8
April	4	3	5	9 $\frac{1}{2}$	1	11
May	2	4 $\frac{1}{4}$	5	0	0	10
June	0	10 $\frac{1}{2}$	3	10	3	5
July	3	6	5	1 $\frac{1}{2}$	2	10
August	6	2	8	6	5	6
September	1	9 $\frac{1}{2}$	9	4	3	4
October	3	10	4	3	4	8
November	6	6	4	0	3	9 $\frac{1}{2}$
December	5	7 $\frac{1}{2}$	8	1	4	8
Total	46	0 $\frac{1}{2}$	65	10	41	0

State of the falls of Rain at Youngsbury near Ware, in Hertfordshire, twenty miles from London. This state was communicated to me by Mr. GOUGH, of Kendal, who says he is indebted for it to Mr. SAMUEL LLOYD of Birmingham, to whom it was transmitted by a Lady, who had paid particular attention to the subject.

	1787	1788	1789	1790	1791
January	1,300	1,440	2,471	2,050	3,360
February	2,210	2,090	} 4,894	0,280	1,910
March	2,163	1,130		0,200	0,980
April	1,630	0,297		1,660	1,950
May	0,930	0,410	1,730	3,210	0,880
June	0,810	2,042	3,910	0,810	0,800
July	3,617	1,313	3,601	3,510	2,960
August	1,580	3,310	1,310	1,960	1,740
September	0,890	3,780	2,754	0,770	0,800
October	3,962	0,140	4,265	1,110	2,420
November	1,542	0,930	2,830	3,690	3,630
December	3,030	0,794	1,730	3,720	2,770
Total	23,664	17,676	29,493	22,970	24,200

A Synoptical Table of the Falls of Rain at different Places in the same Years.

Years.	Liverpool.	Manchester.	Dumfries.	Kendal.	Kelwick.	Lancaster.	Charlworth.	Dover.	Youngbury.	Cardale.	Wath-Sutton.	Fellfoot.
1775	29,6785											
1776	33,1866											
1777	30,1768		34,749				24,794			49,5290		
1778	35,6238		42,354				29,895			61,3660		
1779	26,5302		41,135				24,562			45,9991		
1780	24,8426		40,033				20,441					
1781	31,1866		29,988				23,045					
1782	32,9054		40,918				39,116					
1783	38,5616		33,994				29,526					
1784	30,2802		27,401			35,15	22,976					
1785	25,6240		30,673			36,83	23,162					
1786	26,3428	40,5	32,008			32,30	30,676					
1787	38,0616	47,½	38,657			51,01	32,068		23,664			
1788	25,5988	27,½	26,423	39,2575	34,3057	29,45	19,856		17,676			42,06
1789	48,6870	51	48,093	69,835	72,2449	51,01	36,309		29,493		48,30	66,52
1790	42,5616	42,½	39,354	66,263	64,7439	46,61	26,892	43,36	22,970		45,22	58,48
1791	45,4056	44	39,281	62,200	73,5522	46,05	34,698	44,88	24,200		41,08	
1792	54,2492	55,¼	47,513	84,884	84,6051	65,10	34,740	51,40			57,57	
1793		36,½	34,039	45,580	49,7510	41,00					37,37	
1794				58,048	59,8050							

A FEW OBSERVATIONS ON
RAIN GAGES.

RAIN GAGES, it must be allowed, are imperfect instruments, and that on two accounts: First, from the evaporation which very commonly takes place on the interior surface of the funnel during wet weather in summer; for the air is, for the most part, in a condition to absorb more water than it contains, though (as Mr. Gough observes in a letter which I received from him) our humid atmosphere is sometimes so perfectly saturated, as to deposit a part of its vapour on furniture within doors, even during the months of July and August, provided the weather be very wet; but water will frequently evaporate from the surfaces of many bodies, particularly metallic substances, while rain is falling in summer, or dew is forming in an evening: for if a vessel of tinned iron be rubbed with a wet sponge, and then suspended with its mouth downwards, its inner surface will soon become dry, though rain be falling, or dew forming at the time.

It is certainly necessary to ascertain, if possible, the quantity of water lost by evaporation; for

for according to an ingenious Italian philosopher, nearly double as much water evaporates from an open vessel, as falls into it in the form of rain.* Now, though an evaporation gage may ascertain the quantity of water which evaporates from an open vessel of a given aperture, yet it will by no mean ascertain the ratio between the quantity evaporated from the internal surface of the funnel, and the whole quantity received by the gage. Mr. Gough proposes an ingenious method of determining this point by means of two contiguous gages. For, let A and a = the areas of the apertures of the two gages, B and b = the curve surfaces of their funnels, S and s = the quantities of water collected by them in a given time in grains, X and x = the quantities lost by evaporation. Then $S + X$ and $s + x$ being the quantities received by the gages, we have

$$A : a :: S + X : s + x, \text{ and } x = \frac{a S - A s + a X}{A};$$

but since the quantities evaporated in the same time are as those surfaces, $B : b :: X : x$, and x

$$= \frac{b X}{B} = \frac{a S - A s + a X}{A}, \text{ hence } X =$$

E e e e 2

B a S

* Vide Opere del Padre Giovanni Baptista da St. Martino. Vol. I. Art. 4.

$\frac{B a S - B A s}{A b - B a}$; but the funnels of the two

gages must not be similar, for, in that case, the numerator and denominator would be $= 0$, and consequently nothing could be determined.

The second imperfection to which rain gages are liable, arises from the loss of water occasioned by the drops of rain bursting, when they are driven obliquely by a breeze, and strike the sides of the gage: in such cases, they disperse into a number of minute drops, many of which never descend into the receiver, but escape over the margin of the funnel. This depends on principles too simple to require any experimental proof. It is difficult, if not impossible, to prevent entirely the waste of rain by dispersion; all that we can do is to diminish it as much as possible. Mr. Gough, in the same letter, proposes the following method of remedying this imperfection. A linen strainer, he says, of a conical figure, should be exactly fitted to the mouth of the gage; this flexible funnel should be stretched by a weight or string fastened to its apex within the vessel; the drops, striking on this yielding substance, would receive a moderate concussion, and the particles of water would be entangled in the threads of the cloth. It is sufficiently evident, that this contrivance would greatly prevent the loss occasioned by dispersion,

sion ; but would, at the same time, much increase the evaporation, by detaining a quantity of water in the funnel, and exposing a much greater surface to the air. A better way of correcting this error, is, I think, to have a perpendicular rim an inch or two high, fixed to the rim of the funnel. The form of the gages which I have had constructed for my own use, and that of my friends, is represented in the annexed Plate. (IX. fig. 2.)

In gages of this form, especially when made sufficiently large, Mr. Copland, of Dumfries, informs me, that he found the loss from dispersion nearly, if not entirely, corrected. The area of one of his funnels contains 144 square inches, and the other 288. He has compared these with one of an area of sixteen inches, and always found a smaller than proportional result from this last in windy weather. He says, he has observed his large square gages in stormy falls, and could observe nothing driven over after having struck the inside, and was surprized to see so little lost even during a hail shower. He recommends gages with square apertures, in preference to those of a cylindrical or conical form ; for “ from the rotatory motion which the air always takes when forced over the end of a transversely truncated cylinder, and which emits a whistling noise, the rain will be carried over the edge of the cylinder, and be almost entirely

entirely prevented from falling into the gage." He soon found, he says, after using square gages, that the results from them were much more ample than from some others that were kept in the neighbourhood, which were of a cylindrical form.

A little cup, with its mouth downwards, is fitted to the neck of the funnel as at *A*, which will go over the mouth of the bottle; because it is evident, that when rain is driven against the outside of the funnel, or in consequence of the condensation of dew upon the outer or under side of it, more water would be collected by the receiver than falls within the area of the funnel, if it was not prevented by a contrivance of this kind.

In order to determine the perpendicular height of water which falls upon the ground by means of a rain gage:—If we know the weight of water caught in the bottle, the area of the aperture of the funnel, and the weight of the cubic foot of water, we can easily calculate the perpendicular height. Mr. Dalton, in his *Meteorological Essays*, (page 34) has given a theorem for this purpose: but upon comparing tables which I had constructed for my own use by this theorem, with some which were sent me by Mr. Kirwan, I found that the height given in mine much exceeded that in the tables of this
last

last-mentioned gentleman. I therefore set about the investigation of Mr. Dalton's theorem, and from the same principles obtained an expression which was only $\frac{1}{12}$ of his. But distrusting my own investigation, when contrasted with the known abilities of Mr. Dalton as a mathematician, I wrote to my friend Mr. Dawson, of Sedbergh, desiring his opinion on the subject, and his answer is as follows — "There is certainly a mistake in Mr. Dalton's theorem for determining the height of water fallen upon a given horizontal plane, as you will easily see from what follows.

"Besides the symbols he makes use of (viz. a = the area of the aperture of the funnel, W the weight of a cubic foot of water, and w the weight of the water caught in pounds), put x = the depth of the water fallen in inches, then ax = the number of solid inches in the gage, and because the weight varies as the number of solid inches, $\therefore W : w :: 1728 : ax$,

and $ax \times W = 1728 \times w$, or $x = \frac{1728 w}{a W} =$

depth required. — Mr. Dalton's expression is just twelve times the above. You will easily observe that the 1728 is the number of cubic inches in a solid foot, of which W = the weight in avoirdupoise pounds."

The easiest way of finding the perpendicular height of water fallen, is to measure the water caught

caught in a phial graduated so as to express the weight of the water in ounces and quarters, and to compare this with a table constructed for the purpose.—As many people may wish to keep a rain gage, who are unacquainted with the method of constructing these tables, I shall give one which I formed for my own use.—It will likewise save trouble to those who can construct them themselves.—It is calculated for a gage whose aperture is a square foot. The heights corresponding to different weights (Troy) of water, are expressed in inches and decimal parts.

Weight.	Corresponding heights.	Weight.	Corresponding heights.
lb. oz.	Inches.	lb.	Inches.
0 $\frac{1}{4}$	0,00328	1	0,15763
0 $\frac{1}{2}$	0,00656	2	0,31527
0 1	0,01313	3	0,47291
0 2	0,02626	4	0,63054
0 3	0,03940	5	0,78817
0 4	0,05250	6	0,94582
0 5	0,06560	7	1,10345
0 6	0,07881	8	1,26018
0 7	0,09194	9	1,41771
0 8	0,10507	10	1,57634
0 9	0,11822	11	1,73397
0 10	0,13135	12	1,89160
0 11	0,14448		

Suppose

Suppose the water found in the gage upon examination to weigh 2lb. $8\frac{1}{4}$ oz. Then we have by the table

2lb.	-	0,31527
8oz.	-	0,10507
$\frac{1}{4}$ oz.	-	0,00328

Perpendicular height 0,42362

I have been thus particular, because many persons unacquainted with science, may be induced to keep rain gages, when the method of doing it is made easy—and thus will our general stock of observations be increased.

§ IV.

OF THE WINDS.

Observations on the Winds at Liverpool, abstracted from MR. HUTCHINSON'S Journal.

Concerning the method which Mr. Hutchinson took to estimate the velocity of the winds,

F f f f

I shall

I shall insert an extract of a letter which I received from Dr. Renwick, who, at my request, had the goodness to make inquiries of Mr. Hutchinson.

“ Concerning the velocity of the winds, Mr. H. could not say he was very exact during two or three of the first years of the Journal, as he noted it down from his own judgement; he afterwards tried it by the method of finding the ship's velocity by heaving the log. He fastened a ship's log-line about his waist, while some person who understood the nature of it, attended to the log glass, and line. He made use of a common walking-stick, to the end of which he affixed a cross stick (similar to the yard of a ship,) and to the end of the cross stick he affixed a silk handkerchief. As he ran, the handkerchief was carried forwards by the wind, and when the handkerchief fell flat upon the stick, he judged that he had run as fast as the greatest velocity of the wind. He also tried a similar experiment with a boat, which had two sails before the wind in smooth water, in such as a stiff-sailing ship might carry her top-gallant sails.”

In the following table, D signifies the number of days which the wind has blown from that point during the year; G the greatest velocity of the wind; L the least velocity; and M the mean velocity.

North

	North				N. E.				East				S. E.			
Years.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.
1768	11	25	10	18	24	50	5	21	36	35	15	25	86	40	10	22
1769	10	30	20	22	25	40	10	20	15	40	10	23	89	45	10	22
1770	27	30	5	15	29	45	5	17	13	40	5	13	69	35	5	11
1771	21	30	3	7	26	40	3	6	18	30	3	10	84	35	2	10
1772	12	10	3	7	24	20	3	7	13	25	3	8	137	30	2	7
1773	13	10	3	7	14	20	5	8	10	25	2	6	136	40	2	6
1774	19	20	4	7	29	40	3	8	22	25	3	7	135	40	2	6
1775	13	8	3	5	13	10	3	5	11	15	5	8	124	30	2	6
1776	9	12	3	5	19	30	3	7	19	30	3	6	126	20	2	6
1777	16	10	3	5	37	15	3	6	12	25	3	7	115	25	2	7
1778	13	20	3	6	30	20	2	6	8	15	3	8	137	25	2	6
1779	10	10	3	6	21	10	3	5	13	10	5	7	143	20	2	6
1780	15	20	3	7	30	20	3	6	14	10	5	7	113	20	3	6
1781	5	15	5	9	20	15	5	7	16	10	3	6	141	30	3	7
1782	20	20	3	10	40	15	3	7	18	30	3	9	105	20	2	9
1783	13	15	3	8	34	20	3	6	20	15	3	9	140	25	3	7
1784	20	15	3	7	37	20	3	8	26	15	3	8	95	20	2	6
1785	10	8	3	6	28	15	3	7	19	15	5	9	132	30	2	7
1786	4	8	3	5	46	20	3	8	28	20	5	11	105	20	3	8
1787	13	20	3	7	34	20	3	8	15	35	5	11	124	35	2	9
1788	14	20	3	7	50	20	3	8	23	20	5	9	112	20	3	7
1789	13	10	3	5	28	15	3	7	18	40	3	9	121	20	3	7
1790	8	8	5	6	32	30	3	7	23	20	3	8	102	10	3	6
1791	11	10	5	7	34	20	3	6	25	8	5	7	97	20	3	7
1792	15	20	3	7	28	10	3	6	24	10	5	8	114	20	3	7

South

	South				S. W.				West.				N. W.			
Years.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.	D.	G.	L.	M.
1768	26	30	10	21	40	40	15	24	40	45	10	27	33	40	10	23
1769	19	35	10	19	61	45	10	28	32	45	10	26	61	50	10	24
1770	18	15	3	6	50	45	5	19	64	50	3	16	56	50	5	17
1771	12	12	3	7	42	40	3	13	50	45	3	16	67	40	3	9
1772	18	20	2	6	56	22	3	10	45	30	3	11	46	40	2	7
1773	7	7	5	5	50	45	3	8	45	30	3	11	55	25	3	7
1774	4	5	3	4	47	20	3	9	54	30	3	12	51	30	3	10
1775	9	7	3	5	54	45	3	12	53	30	3	12	63	25	3	10
1776	8	10	3	6	46	30	2	9	52	40	2	11	64	30	3	8
1777	8	10	2	4	36	30	3	11	54	30	3	11	51	20	2	7
1778	4	10	3	7	59	40	2	11	39	30	2	12	54	20	3	8
1779	10	8	3	6	57	30	3	10	40	30	3	11	62	30	2	8
1780	4	5	3	5	62	30	3	10	46	35	3	12	63	25	3	10
1781	6	8	3	5	53	30	2	10	47	30	3	11	71	30	3	11
1782	2	10	7	8	65	25	3	13	66	35	3	13	48	30	3	13
1783	5	10	5	7	51	40	5	12	39	30	3	12	57	20	3	9
1784	8	8	3	4	52	30	3	10	53	30	3	11	55	15	3	10
1785	9	15	3	7	42	30	3	11	58	35	3	15	71	25	3	10
1786	10	10	2	5	54	40	3	12	50	40	2	13	57	30	3	9
1787	9	25	3	6	66	40	3	14	47	30	3	11	56	45	3	7
1788	11	10	3	6	46	40	3	12	58	30	3	9	53	40	3	9
1789	7	30	3	11	71	40	3	11	39	30	3	11	42	25	3	9
1790	4	8	5	6	54	45	3	11	56	30	3	11	55	20	3	7
1791	3	7	3	5	70	50	3	11	55	40	3	11	51	40	3	10
1792	6	15	5	7	69	30	5	9	45	40	5	9	47	25	3	8

The annual mean deduced from this table is as follows ;

North.		N. E.		Eaft.		S. E.	
No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity
13	8	29	8	18	9	115	8

South.		S. W.		Weft.		N. W.	
No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity	No. of days.	Mean velocity
9	7	54	12	49	13	58	10

Taking the North and Eaft winds in oppofition to the South and Weft, they will ftand as follows.

		Days.			M. V.
North	-	13	-	-	8
N. E.	-	29	-	-	8
Eaft	-	18	-	-	9
S. E.	-	115	-	-	8

Total of the North } Mean Velocity } 84
Eafterly winds. } 175 of N. E. winds. }

		Days.			M. V.
South	-	9	-	-	7
S. W.	-	54	-	-	12
Weft	-	49	-	-	13
N. W.	-	58	-	-	10

Total of the South } Mean Velocity } 10½
Wefterly winds. } 170 of S. W winds. }

State

State of the direction and mean velocity of the winds in each month, deduced from an average of twenty-five years.

Months.	North.		N. E.		Eaft.		S. E.		South.		S. W.		West.		N. W.	
	Days.	Mean Velo-city.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.	D.	M.V.
January	1	9	3,5	9	2,1	13	7,8	8	0,5	7	3,4	13	3,9	13	5,	12
February	0,92	11	2,28	10	1,16	11	8,3	9	0,8	10	5,5	14	4,16	15	2,5	10
March	1,4	8	3,9	10	1,9	11	9,4	9	0,6	9	4,8	12	4	13	3	9
April	1	9	3,5	9	2,1	13	7,8	8	0,5	7	3,4	13	3,9	13	5	12
May	0,8	8	3	10	1,8	10	9,7	7	1	7	3,6	13	3	12	7	8
June	0,8	9	2	7	1,3	8	7,8	7	0,8	7	3,7	14	4,7	10	6,8	8
July	0,6	7	1	7	0,4	8	7,5	7	1	7	4,7	11	6	9	8	8
August	0,7	8	0,7	7	1,3	10	9	7	0,9	8	4	10	5,6	12	6	8
September	0,7	7	1,6	7	1,4	9	12	8	0,5	7	5	10	3,4	12	4	9
October	1,2	7	2,3	7	2	9	11	8	1	8	5	11	3	11	2,7	8
November	1,2	9	3	8	1,2	9	10	9	0,7	8	3,9	12	3,5	15	3,3	14
December	1,8	7	2,4	7	1,5	8	10,5	8	0,8	6	4	13	4	16	2,6	12

Observations on the Winds at Dover, abstracted from Mr. Mantell's Journal.

1790.												1791.												1792.											
	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW	N	NE	E	SE	S	SW	W	NW											
January	1	6	0	6	2	22	3	5	2	2	0	1	2	29	8	7	5	14	0	6	3	15	1	4											
February	0	2	0	1	0	23	3	6	0	10	1	2	1	14	5	7	2	10	1	1	1	14	0	12											
March	2	22	4	6	0	10	0	5	9	9	0	1	0	19	1	15	0	5	0	1	0	25	0	5											
April	2	16	7	6	2	8	1	3	12	12	6	2	0	17	2	8	0	13	0	1	0	14	0	11											
May	4	14	2	5	0	16	0	1	15	16	0	2	1	16	5	3	0	12	0	1	1	12	5	5											
June	0	12	0	1	1	19	3	7	16	1	1	0	0	11	1	7	2	8	1	1	0	15	5	8											
July	2	3	0	0	0	26	0	6	3	3	3	0	0	22	2	7	4	6	0	3	1	19	4	7											
August	4	3	0	3	0	25	5	8	3	9	0	0	0	19	5	2	1	2	0	5	0	6	1	9											
September	2	9	1	6	0	18	3	8	3	14	4	7	0	9	4	7	3	0	2	1	0	11	7	0											
October	3	14	4	11	0	15	2	5	3	9	1	10	2	14	6	8	1	11	5	4	2	13	1	16											
November	1	12	4	9	2	13	1	2	2	5	0	7	0	17	5	3	0	7	2	3	0	15	4	6											
December	5	6	1	2	1	23	2	10	3	8	1	5	2	14	4	9	3	7	2	3	0	8	7	22											
Total in each year	27	129	23	46	8	218	23	66	30	112	17	37	8	201	48	93	24	113	14	28	9	167	33	115											

Upon an average of three years, the winds have blown as follows.

North	N. E.	East.	S. E.
27	118	18	37

South.	S. W.	West.	N. W.
8	195	35	91

Taking the North and East winds in opposition to the South and West, they will stand as follows.

	Days.		Days.
North	- 27	South	- 8
N. E.	- 118	S. W.	- 195
East	- 18	West	- 35
S. E.	- 37	N. W.	- 91
	<hr/> 200		<hr/> 329

State of the Winds in each Month, on an average of three Years.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
January	2,7	7,3	0	4,3	2,3	22	4	5,3
February	3	7,3	0,7	1,3	0,7	17	2,7	8,3
March	2,7	12	1,3	2,7	0,3	18	0,3	8,3
April	1,7	13,7	4,3	3	0,7	13	1	5,7
May	3	13,7	0,7	2	0,7	14,7	3,3	6
June	2	12	0,7	1,3	0,3	15	3	7,3
July	3	4	1	1	0,3	22,3	2	6,7
August	2,7	10	0,7	2,7	0	16,7	0,3	6,3
September	2,7	8,3	2	4,7	0	12,7	4,7	0,3
October	2	11,3	3,3	8,3	1,3	14	3	6,3
November	1,3	8	2	6,3	0,7	15	3,3	3,7
December	3,7	7	1,3	2,7	1	15	3,7	13,7

*Observations on the Winds at Dumfries, by MR,
COPLAND, continued from p. 272.*

In 1793 the wind was	No. of days.	Above the Medium.	Below the Medium.	Medium for 9 Yrs.
North	32		4,17	36,17
N. W.	26	1,45		24,55
East	77	10,33		66,67
N. E.	15		,5	15,5
Total of the N. E. winds.	150	7,11		142,89

In 1793 the wind was	No. of days.	Above the Medium.	Below the Medium.	Medium for 9 Yrs.
South	75		1,11	76,11
S. E.	18		2,16	20,16
West	61 $\frac{1}{2}$		12,79	74,29
S. W.	60 $\frac{1}{2}$	8,95		51,55
Total of the South Westerly winds.	215		7,11	222,11

Prevalence of the South Westerly Winds 65 Days.
Before

Before the publication of the BOTANIC GARDEN, the world was not in possession of any rational theory of the winds; that of Dr. Halley, and others which have succeeded it, not being sufficient to explain a variety of phenomena, and being evidently contradicted by some. Since Dr. Darwin's theory appeared, Mr. Dalton has published one on similar principles, which (as I believe he was totally unacquainted with Dr. Darwin's at the time he wrote) is a circumstance certainly not unfavourable to the theory. As many of the phenomena of meteorology admit of an easy and satisfactory explanation by Dr. Darwin's theory, and as some circumstances relative to the winds at Liverpool, cannot be well understood without it, I shall transcribe a short outline of it, which the ingenious author gives by way of recapitulation.

“ NORTH - EAST WIND consists of air flowing from the North, where it seems to be occasionally produced; has an apparent direction from the East, owing to its not having acquired, in its journey, the increasing velocity of the earth's surface. These winds are analogous to the trade winds between the tropics, and frequently continue in the vernal months for four and six weeks together, with a high barometer, and fair or frosty weather. 2. They

G g g g 2

some-

sometimes consist of South-west air which had passed by us or over us, driven back by a new accumulation of air in the North. These last continue but a day or two, and are attended with rain.

SOUTH-WEST WIND consists of air flowing from the South, and seems occasionally absorbed at its arrival to the northern latitudes. It has a real direction from the west, owing to its not having lost in its journey the greater velocity it had acquired from the earth's surface from whence it came. These winds are analogous to the monsoons between the tropics, and frequently continue from four to six weeks together, with a low barometer, and rainy weather. 2. They sometimes consist of north-east air, which had passed by us or over us, which becomes retrograde by a commencing deficiency of air in the north. These winds continue but a day or two, attended with severe frost with a sinking barometer; their cold being increased by their expansion as they return into an incipient vacancy.

NORTH WEST WINDS consist, first, of South-west winds, which have passed over us, bent down and driven back towards the south, by the newly generated northern air. They continue but a day or two, and are attended with rain or clouds. 2. They consist of north-east winds,

winds, bent down from the higher parts of the atmosphere; and, having there acquired a greater velocity than the earth's surface, are frosty and fair. 3. They consist of north-east winds, formed into a vertical spiral eddy, as on the eastern coasts of North America, and bring severe frost.

SOUTH-EAST WINDS consist, first, of North-East winds become retrograde; continue for a day or two: frosty or fair, sinking barometer. 2. They consist of North-East winds formed into a vertical eddy, not a spiral one; frost or fair.

NORTH WINDS consist, first, of air flowing slowly from the North, so that they acquire the velocity of the earth's surface as they approach; are fair or frosty; seldom occur. 2. They consist of retrograde south winds; these continue but a day or two; are preceded by south-west wind; and are generally succeeded by north-east winds, cloudy or rainy, barometer rising.

SOUTH WINDS consist, first, of air flowing slowly from the south, losing their previous western velocity by the friction of the earth's surface as they approach; moist, seldom occur. 2. They consist of retrograde north winds; these continue but a day or two; are preceded by north-east.

north-east winds; and generally succeeded by south-west winds, colder, barometer rising.

EAST WINDS consist of air brought hastily from the north, and not impelled farther southward, owing to a sudden beginning absorption of air in the northern regions; very cold; barometer high; generally succeeded by south-west winds.

WEST-WINDS consist of air brought hastily from the south, and checked from proceeding further to the north by a beginning production of air in the northern regions, warm and moist, generally succeeded by north-east wind. 2. They consist of air bent down from the higher regions of the atmosphere; if this air be from the south, and brought hastily, it becomes a wind of very great velocity, moving perhaps sixty miles an hour, is warm and rainy; if it consist of northern air bent down, is of less velocity, and colder."

From this theory we may conclude, that all our winds in this country which blow from the north or east, or any point between them, consist of regions of air brought from the north; and that all our winds blowing from the south or west, or from any point between them, are regions of air from the south; and that, in places where there are no local circumstances which divert the winds from the course they would

would naturally take, the north-east and south-west winds will be most frequent; as is the case at Dover, Lancaster, Kendal, &c. At Liverpool, however, a remarkable deviation takes place. From the tables here given it appears, that the wind blows much more frequently from the south-east than from any other point; and on comparing it with the winds at Dover, in the table here given, with the winds at Lancaster, p. 265 of this volume, and those of Kendal in Mr. Dalton's *Essays*, it appears, that both the south-west and the north-east winds at Liverpool are deficient. As this takes place constantly every year, it can only be accounted for on the supposition of some permanent local cause. It probably depends upon an atmospheric eddy, produced by the south-west winds striking obliquely against the English appenine, and being hence converted into south-east winds. The same will happen, in some degree, to the north-east winds. This eddy is probably similar to that, which causes the frequent north-west winds on the eastern coast of North America. These are the freezing winds, as appears from a variety of testimonies, and are evidently produced by an atmospheric eddy: for when a sheet of air is flowing from the north-east, and rising from the shore in a straight line to the summit of the Apalachian mountains,

mountains, a part of the stream of north-east air will flow over the mountains, another part will revert and circulate spirally between the summit of the country and the eastern shore, continuing to move towards the south; and thus be changed from a north-east to a north-west wind. (See Botanic Garden, part 1st).

In a letter which I lately received from Dr. Darwin, he coincides with me in opinion, that "the prevalence of the south-east winds at Liverpool, depends upon some atmospheric eddy produced by the situation of the place." In the same letter this ingenious philosopher observes, "that the knowledge of the winds, their origin or cause, is the principal source (I mean the cause) not the consequence of all the other atmospheric phenomena in my opinion. All the winds of the N. E. come directly from snowy countries; and as the snow is evaporated by them, great cold is produced: first by the thawing of the snow into water, and then by evaporating the water, which I suppose to be done at one process by the air. Then the south-east winds, when they bring frost, are superior currents of north-east winds driven back. These I esteem to be the sources of frost in this country. And how these winds are produced or generated for six weeks together, seems to me to be the greatest desideratum, as I have endeavoured to show in a note in the Botanic Garden.

“ Experiments

Experiments on freezing and thawing in a perfect vacuum might give light to this subject: as I suspect, from the great expansion of ice, that air must be generated in the act of freezing, and given out in thawing. A bit of ice might easily be dissolved in the Toricellian vacuum, to ascertain whether it parted with air in thawing."

Soon after I received this letter, I endeavoured to subject this opinion to an experimental proof, in the following manner;

As much water was put into the upper end of a wide barometer tube, as filled it to two inches: it was then frozen in a freezing mixture, the tube was filled with mercury, and inverted into a vessel of the same.—The mercury did not remain suspended so high as the ice, but there was a vacuum of about a quarter of an inch between them. The place where the mercury stood was accurately marked, and the ice was suffered to thaw, which in about half an hour was completely done. The water was supported upon the mercury to the height of about two inches, and the mercury was found depressed very nearly $\frac{1}{4}$ of an inch, which was undoubtedly owing to the pressure of the two inches of water. When the tube was inclined, the water and mercury entirely filled it; a proof that no air had been extricated during the thawing of the ice.

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I next made the experiment on a large scale, in the following manner;—a tall glass jar which held near half a gallon, was filled with broken pieces of ice, water was poured into it to expell the air from the interstices, the jar was then carefully inverted in a vessel of water, and the ice suffered to thaw, but no air was extricated excepting a small bubble not the size of a pea, which was probably confined between the particles of the ice, as we generally see it. As the ice melted, I introduced more in pieces, by just raising up the edge of the jar, but not above the water. The pieces of ice being specifically lighter than the water, arose to the upper part of the jar. In this manner I introduced on the whole not less than ten pounds of ice, yet no air was extricated.

From the result of these experiments, may we not conclude, that we are yet ignorant of the nature of the "*Great Bear or Dragon*" of the north, which at times suddenly drinks up, and as suddenly at other times vomits out one fifteenth part of the atmosphere?"

APPENDIX.

(A.)

COPY OF A LETTER FROM MR. COPLAND, OF
DUMFRIES.

DEAR SIR.

I MOST readily seize this opportunity to correct the last observations in my letter of January 15th. 1793, (see page 271). The state of the phenomena appears from farther experience to be different from what is there expressed.

When two rain-gages are kept at different altitudes, and at no great distance from each other, the quantities of water collected by them are found alternately to exceed each other on a variety of occasions. The lowest of my gages stands only two feet above the ground; the superior seven feet. In all heavy rains, or when the falls are of any duration, the former exceeds the latter at a medium of about a twenty-fifth part of the whole quantity in the gage; and in summer this excess appears to be greater than in winter. So great an increase of precipitation in a difference of only five feet of altitude in the atmosphere, is a proof that the stratum or portion of air, which is in a precipitating state, is probably of no great depth: For when allow-

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ance is made for the greater rarity above, it should not, on these occasions, extend beyond two hundred feet from the surface. But frequently in the finest weather, when the precipitation seemed to be confined near the surface, as in the time of fogs and heavy dews, the inferior exceeded the superior gage one half, and on some occasions, received the whole of the quantity precipitated. In like manner, at the beginning of most falls, the precipitation seems to be most copious near the surface, and gradually to ascend, or proceed from a more elevated portion of the atmosphere; till at last, when the fall is nearly over, the stratum next the surface, is not only *not* in a precipitating state, but then beginning to re-absorb moisture, and to be disposed to combine with it again. In such cases the inferior gage becomes *minus*, and when so, is no doubt a sign that the rain is nearly over. Yet from this circumstance no conclusion can be drawn, how long it may continue fair; as in some cases the precipitation has been observed to commence in a few hours, and run on again as before. On very few occasions did the precipitations appear to have proceeded at the beginning from an elevated portion of the atmosphere, as the inferior gage was *minus*; and, at the end of these falls, it was as certainly observed to be *plus*. There is therefore
reason

reason to conclude, that when the precipitation begins from an elevated portion of the atmosphere, it ends near the surface, and *vice versa*.

It appears to me, that the only indications respecting the weather which can be taken from two gages placed as above, should be expressed as follows; viz. That when the excess in the under gage continues to be absent a twenty-fifth part, or something less, of the whole quantity, the fall will not be soon over, as the precipitation is going on pretty generally, or through a large portion of the atmosphere; but when the quantities in the gage are equal, or the inferior one either remarkably *plus* or *minus*, after having been for some time *plus*, the fall will probably soon be over; because there is then reason to conclude, that the precipitation is confined to a thin stratum of the atmosphere. Some instances of this nature having occurred after I began to keep my gages situated as above described, I was induced to infer that to be a general rule, which is just only in particular situations.

With regard to another observation, stated in that letter, respecting the barometer, I think many phenomena of the weather, observed since that time, have confirmed it. But I shall only notice what happened last winter, when the application of such rules should be
most

most conspicuous, from the temporary influence of the sun having less effect in varying the natural phenomena.

It is not easy in any other way, to account for the want of severe cold, and almost of frost also, till long after the year was finished, when the weather was dry, except from its being accompanied with the highest barometer, and that for the longest period of time perhaps ever remembered at the season; and it is very remarkable we had here more than three weeks, near the middle of winter, of perfectly dry weather without any frost, except two mornings, when it was so slight as to disappear entirely by mid-day, owing to the influence of the sun; all which time the wind blew from the North and Easterly points, which very seldom occurs at that time without hard frost.

During that period, the mean of the barometer, from the 15th. of November, to the 8th. of December, was full thirty inches, being more than $4\frac{1}{2}$ tenths above the medium of the season. The mean heat was 44.52 degrees, being five above the medium; and the falls were about one-third of what usually takes place at that time: but these being not altogether the complete or adequate consequences of such an aberration of the barometer, heat or dry weather was still to be expected. Accordingly a most remarkable

remarkable warmth took place, in the midst of great falls of rain, for about three weeks after.

I wish to observe farther, that on inspecting the state of the barometer, thermometer, and falls, during the year 1793 (which has been made out as accurately as my time and leisure would permit) it will appear that every aberration of the barometer has been accompanied or followed by an evident deviation of temperature above or below the medium of the season, taken together with a greater or lesser extent of falls; and is, if not completely answered during the month, or in the commencement of the next, always sufficiently compensated for at some distance. It also appears that this rule may be depended on, viz. that when a change of weather, either to good or bad, has been indicated by undoubted signs, and is impending; the longer it is delayed, the more complete it will be whenever it commences. Thus we find the height of the barometer in January not being completely answered in that month, that in February the heat that was owing ensued, notwithstanding the lowness of the barometer; which again seems to have been fully answered by the extent of falls. In March, the cold and falls being more than proportionate to the state of the barometer, warm or fair weather was therefore due. This
however

however was not duly paid in April, May, or June; but the account was at last completely balanced in July. The remaining months will be found to proceed in a similar manner.

But, lest my former explanation of these phenomena should be less complete or distinct than could be wished, I shall endeavour to express my meaning in other words, and with as much precision as possible. Every aberration, then, of the barometer above or below the medium of the season, when not completely balanced by an equal deviation in the opposite direction, is either accompanied, or (what is most frequently the case) is followed by one of the three following consequences: Every tenth of an inch of rise or fall in the barometer is answered, in the first place, by nearly two degrees of heat being added to, or subtracted from, the mean heat of the time. 2d. It is answered by nearly one half less, or one half more of falls, than what is the usual quantity which is precipitated in that season. And 3d. It is answered by both these consequences together. This is what most frequently occurs; but the proportions nearly as here stated are always taken in the account.

I by no means pretend to say, that these consequences are absolutely to be expected; because several circumstances often seem to
occur

occur which prevent them from being immediate or complete ; such as, first, the uncertainty whether these alterations of the barometer are accompanied, are to be soon followed, or are only at a considerable distance of time to be answered by these phenomena. 2d. When the temperament or disposition of the season has a tendency to be dry or wet, the weather will resist several opportunities or indications of change,* before it will alter its present state. And 3d. a considerable fall, or a great degree of heat or cold coming on suddenly, will completely answer a greater aberration of the barometer, and for a longer time than what would otherwise have been the case. The greater falls in the beginning of last year, and the lesser towards the end of it than what were indicated by the barometer, may be sufficiently accounted for from the second of these positions.

It was suggested to me by some intelligent persons, that a Calendar of Flora, properly conducted, might be of use to ascertain in what parts of the Island the seasons are more or less early or late ; and whether a tendency to degenerate and grow colder can be observed in the climate of this country : a supposed consequence of what has been by some persons

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* See page 243.

alleged of an increase of ice to the northward.* I have therefore endeavoured to collate one which was only begun in May last, with one kept by the Rev. Dr. Burgefs, of Kirkmichael, about eight miles north-east of this town, from the year 1773 to 1776. I have confined myself to those subjects that are generally to be met with in every part of the kingdom. From my carrying on business in a town, my opportunities for such an undertaking are not so complete as could be wished, but in future I hope to be assisted by others, who may be, in every respect, better situated for such observations.

A Calendar

* This point has been much disputed. M. De Luc supports the idea here mentioned. He expresses himself as follows. "One cannot doubt concerning the increase of all the Glaciers of the Alps; their *very existence* is a proof, that in preceding ages, the quantity of snow which has fallen during the winter, has exceeded the quantity melted during the summer. Now, not only the same cause still subsists, but the cold occasioned by the mass of ice already formed, ought to augment it still farther, and thence more snow ought to fall, and a less quantity of it must be melted." Though this fact be admitted, it is contended by a learned member of this Society, that it by no means follows that there is an annually increasing quantity; for besides the heat of the air in summer, there is another cause which tends to prevent any *indefinite* augmentation of congealed

CALENDAR of FLORA, for M.DCC.XCIII.
kept at Dumfries.

May 3d. and for the three following days, the common Swallow (*Hirundo rustica*) came.

— 8th. The large Martin or Swift (*Hirundo Apus*) came, and the same day the Cuckoo, (*Cuculus canorus*) was first heard.

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June

gealed water: the *internal heat of the earth.*† The general heat of the springs of water situated deep in the bowels of the earth, is about forty-eight degrees. In mountainous countries it may be somewhat less, but sufficient notwithstanding for the purpose here mentioned. When the snow incumbent on any spot of ground, is but thin, it may so far cool the earth, that the internal heat may not be able to dissolve it; but when the bed is thick enough to protect the earth from the influence of the atmospheric cold, that surface of the earth may, even in the coldest winters, receive more heat from the earth than cold from the atmosphere, and be therefore dissolved at all seasons of the year.

Now we know that facts are in favour of this reasoning; for streams of water, and even rivers issue from the bottom of the Glaciers in the Alps, in the greatest severity of winter: so that whether this be allowed to depend upon the internal heat of the earth or not, a constant thaw of the ice or snow which is contiguous to the surface of the earth, cannot be denied; and this added to other causes, may render it probable that the quantity of congealed water has its limit even in the coldest country.

† Watson's Chemistry, vol. III. p. 184.

June 25th. A few of the early strawberries and cherries on the walls ripe; and, in favourable situations, the lowest flowers of the Fox Glove (*Digitalis purpurea*) in full blow.

— 27th. The sown grafs begun to be cut for hay.

— 30th. Wheat beginning to shoot.

July 9th. Some flowers of the Elder (*Sambucus Ebulus*) in full blow, and most near opening.—A few of the middle flowers of the Mugwort (*Artemisia vulgaris*), and also some on the Horse Thistle beginning to open.

— 12th. Common Thistle ditto.—The oats and barley shooting fast, and the cutting of hay in the midst, which was on the whole a thin crop.

— 20th. The small sea Trout (a species of salmon) called here the *Hirling*, beginning to run hard in the river.

August 1st. The wheat and barley beginning to alter in colour in a few places.

— 4th. The Swift (*Hirundo Apus*) gone, and oats beginning to colour.

— 12th. One field of barley and another of oats, cut near the town.

— 28th. Harvest became general in the vale of Nithsdale.

Sept. 14th. The Bramble Berry (*Rubus fruticosus*) beginning to be ripe.

— 21. Some of the berries on the Elder (*Sambucus Ebulus*) beginning to colour. The crops all cut down except late fields and patches. The House Swallow (*Hirundo rustica*) beginning to depart.

— 23d. The swallows gone.

— 30th. The crops all got in except late fields, &c.

Oct, 1. The leaves beginning to fall from some of the ash-trees and limes. The berries the elder and bramble in the midst of ripening, but have little flavour. Some grain on a very late soil only cutting, at five miles distance from this place.

Nov. 1st. That late crop now got in, and thus concluding one of the finest harvests ever known in this country, the late grain being equally well ripened and got into the barns with the most early, and over the whole country a heavy crop.—The first snow was visible on the tops of the mountains yesterday; and the first frost, of any consequence, was noticed this morning.

— 10th. Most of the potatoe ground now sown with wheat, there being little more wheat except on fields where potatoes were growing sown in the country.—Many wild geese (*Anas Anser*), field-fares (*Turdus pilaris*), wood-cocks

cocks (*Scolopax rusticola*) and other northern birds came about this time.

Dec. 8th. Most of the wheat so far sprung as to be out of the power of the frost to hurt it.

— 20th. The grafs on good pastures looking very green in consequence of the mild weather, and many of the furze bushes (*Ulex europæus*) beginning to blossom.

— 25th. Some small furze bushes covered with blossoms, and the wall-flowers (*Cheiranthus Cheiri*), blowing freely.

*Calendar of Flora, by the Rev. Dr. BURGESS,
of Kirkmichael.*

Feb. 8, 1776. The Sky Lark (*Alauda arvensis*) began to sing.

— 10th. The Lapwing (*Tringa Vanellus*) appeared.

March 15th. Oats begin to be sown on good soils.

— 17th. The Curlew (*Scolopax Arquata*) appeared.

— 31st. The Sand Martin (*Hirundo riparia*) came.

April 24th. The Cuckoo (*Cuculus canorus*) sung, which it was observed to do for the first time on the 27th, of the same month, 1775.

Feb.

Feb. 27th. Barley sown.—It was begun to be sown on the same day 1774.

—— The House Swallow (*Hirundo rustica*) appeared.

—— 29th. 1775. The little black Martin (*Hirundo urbica*) came.

May 2d. 1775. The House Swallow appeared.

—— 8th. 1774 and 1776 the same, and the little Martin also appeared.—On the 4th. 1773, the tops of the hills were covered with snow, and during the first fortnight of the month there was generally a frost in the morning, which did much damage to the fruit, potatoes, &c.—On the 15th. 1776, the little Martin appeared.—17th. 1775, the great black Martin (*Hirundo Apus*) appeared.—20th. 1775, the Goat-sucker (*Caprimulgus europæus*) appeared.—27th. 1776, the large Martin or Swift came.—July 22d. 1774, the grain not fully shot.—29th. 1776, barley cut that had been sown April 27th.—31st. 1775, barley cut in an early part of the country.—August 6th. 1775, oats colouring fast, and on the 17th. wheat cut.—10th. ditto the Goat-sucker disappeared.—14th. of same year the great Martin or Swift disappeared.—22d. 1775, harvest became general.—18th, of ditto, oats cut, which were sown March 14th. interval one hundred and fifty-seven days.—September 5th. 1776, wheat cut, which was

was sown March 27th. interval one hundred and sixty-two days.—6th. 1773, oats cut.—7th. 1774, oats cut down the 15th. of March, being the hundred and seventy-sixth day from the time of sowing, which gives a medium for the commencement of cutting oats in this country to be about the 31st. of August, or the 1st. of Sept. and for the time of oats being in the ground, before it is fit for reaping, one hundred and sixty-five days.—August 30th. 1776, barley cut that was sown April 27th.—September 1st. 1774, barley cut that was sown May 1st. which gives a medium for the commencement of the cutting of barley to be in this country about the 22d. of August, and for the time of its being in the ground before it is fit for reaping, one hundred and thirteen days.

September 5th. 1774. A sharp frost which hurt the late grains, and damaged the potatoes. 18th. of ditto, the house swallow departed.—25th. the little martin disappeared.—6th. 1775, house swallows gone.—23d. some of the little martins gone.—30th. 1775, harvest mostly finished, but in 1773 and 1774, harvest not nearly concluded before the end of October. He states, that the harvest 1772 was particularly wet; the falls in the three last months of that year being 21,3 inches in depth, and that the grain was so lodged, grown, and rotted, that
a great

a great part of it was lost; and that some farmers of a dilatory disposition had not got in all their grain on the 23d. of December. He also observes, that the martins and house swallows appear about ten days sooner on the coast of Solway Firth, and about Dumfries, than where he resides.

On the 29th. of December 1775, he takes notice of an earthquake being felt upon his site, through all Annandale and Crawford Moor, which continued about fifteen seconds.

I have the honour to be, dear Sir,

Your most obedient, &c.

ALEX. COPLAND.

Dumfries,
Feb. 2d. 1794.

(B.)

Meteorological Observations, by DR. CAMPBELL, of Lancaster.

I. When the wind is in the S. W. quarter in the summer and autumnal seasons, and the temperature of the air is unusually cold for the season of the year, both to the feeling and the thermometer, with a low barometer, it is a sign that much rain may be expected. These appearances are accounted for by the author of the *Botanic Garden* with his usual ingenuity, upon the principle of the sudden expansion of the air coming from the south, occasioning cold, and a precipitation of its moisture.

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II. All

II. All heavy rains, viz. such as swell the rivers considerably so as to occasion floods, come on with the wind at S. and from that to the S. W. ; and mostly terminate with the wind increasing in force, and veering round to the west. When the wind is in the other points, the weather is generally dry, or if it rains, the rain is neither heavy nor lasting.

An additional reason why these winds are so productive of rain, in this situation, seems to be, that when they bring the clouds loaded with moisture from the south and south-west quarters, these are driven with violence against, or forcibly attracted by the high range of hills, which divide Yorkshire from Westmorland and Lancashire. In consequence of this their contents are more completely deposited on this side of these mountains, than would have been the case had the country been more level. I have been informed, that the deposition is frequently so complete on the western side of these hills, that whilst we are deluged with rain, the clouds which pass over to the Yorkshire side appear fleecy and light, and that the weather is dry. A case which I believe is not uncommon, where a high ridge of hills runs through a country.* This

* Dr. Campbell's observation is very just. The summer of 1792 was remarkably dry in Yorkshire, and all the eastern side of the English Appenine, was burnt up for want of rain ; while on the western-side they had plenty of rain, and most abundant crops of grass. T. G.

This influence of the hills in attracting the clouds, and occasioning a superabundance of rain, is no where more conspicuous than at Kendal, where (though only twenty-one miles distant) the quantity that falls is one-third more than at Lancaster; and it is by no means unusual to see, from the church-yard at Lancaster, the hills about Kendal involved in thick clouds, whilst the sky on this side Farlton-Knott (a high rock about two miles north of Burton) appears perfectly clear.

A very strong instance of this influence came under my observation a few years ago. I was at *Peel Castle*, which is situated on an Island at the westernmost point of that low tract of country, which stretches about ten miles from the foot of the Lancashire mountains, near Ulverstone, to the westward, where it meets the sea. The wind was strong from the S. W. the day cloudy, with sun-shine at intervals; but not a drop of rain. On going the next day to Ulverstone, we found the roads perfectly dry till we came within three or four miles of the town, when we saw marks of heavy rain, and found upon inquiry, that it had rained there the whole afternoon. Here the clouds which passed readily over the low tract of country, on approaching the high hills, were attracted by them, producing an additional quantity of rain in their vicinity.

Remarks on the Barometer.

III. Taking the generally adopted ideas to be just, viz. that when the quicksilver is high (or towards thirty inches) with the wind to the north of the west and S. E. points, it is an indication of fair weather (provided it has not risen too suddenly); and that when the quicksilver is low (or towards twenty-eight inches,) with the wind in the S. or S. W. points, it is an indication of rain; my expectations of the *more immediate future state of the weather*, in any situation of the quicksilver, are taken from the appearance which the surface of the quicksilver in the tube exhibits. If this be convex (i. e. with a roundish, somewhat globular appearance) it is a certain indication that the quicksilver is either rising, or that it keeps a propensity to be stationary, in opposition to a falling state. On the contrary, when the surface of the quicksilver exhibits a concave, ragged, or flat appearance, it shows that it is dropping, or that it has no tendency to rise. The reason of these appearances seems to be, that when the quicksilver is rising in the tube, the particles nearest the sides are attracted by the glass, and retarded in their progress upwards, whilst that part of the quicksilver which is towards the center of the tube, being out of the influence of this attraction, rises with more freedom,

freedom, and consequently higher, and thus gives the bulbous or convex appearance. On the contrary, when the quicksilver is falling, the same attraction subsisting betwixt the particles of quicksilver in approximation to the sides of the tube and the glass, these will be retarded in their descent; whilst the quicksilver towards the center will sink more freely, and the concave, irregular, or flat appearance will obtain as the tendency to sink is more or less prevalent; for the more it is disposed to fall, the more concave will the surface be. But to make this appearance of the quicksilver properly conspicuous, the tube of the barometer should be of a certain size, *c. g.* about half an inch in diameter: because when the diameter of the tube is very small, the quantity of the quicksilver that will be attracted by the sides of the tube, will bear so large a proportion to the whole, as always to exhibit a convex appearance; whilst if the tube be very large, the proportion of the quicksilver that will be within the attraction of the sides of the tube, will be so small, that the convexity will be scarcely discernible, and it will always exhibit a flat or concave surface, as I have seen to be the case with a barometer of nearly an inch diameter.

(c)

*Observations on the Temperature of the Sea at
Liverpool, by the late MATTHEW DOBSON, M. D.
Communicated by Dr. PERCIVAL.*

The ingenious Count Marfigli in his philosophical Essay towards a history of the sea, from which the Royal Academy of Sciences at Paris have made a number of extracts, observed, that the heat of the sea at different depths, provided the depths be very considerable, is nearly equable; that the degree of heat is about temperate, or fifty-one degrees of Fahrenheit's Thermometer; and that the variations which were discovered towards the surface, are either the effects of climate, or arise from the particular circumstances of exposure on different coasts.

It may be of use therefore to ascertain the different temperatures of the sea at different seasons, and on different shores; that physicians may with certainty direct their patients to such places; and at such seasons as are best adapted to their respective constitutions and complaints.

The variations in the temperature of the sea at Liverpool, are considerably greater than on any other coast, and arise from very obvious causes. The sea, before it enters the river Mersey, is diffused over a wide extent of flats and sand-banks, which are in many parts left dry, during certain times of the tide. The
heat

heat of the summer, therefore, and the cold of the winter have a very powerful effect to alter the natural temperature of the sea.

To ascertain these variations an experiment was made, about the middle of each month, at high water, and during the time of spring tides. The experiment was made with Fahrenheit's Thermometer, and where the river enters the new dry dock.

The first column of the following table contains the temperature of the sea; the second the temperature of the open air in the shade at eight o'clock in the morning of the same day during the year 1772; and the third column the temperature of the external air at two in the afternoon.

1772	Temperature of the sea.	Air at 8 A.M.	Air at 2 P. M.
January	36	34	38
February	36	33	39
March	38	38	43
April	47	48	49
May	55	53	58
June	64	62	65
July	68	65	69
August	65	63	67
September	60	57	61
October	55	53	58
November	44	40	47
December	48	38	43

From

From this table it appears, that the temperature of the sea at Liverpool, varies during the course of the year 32° . viz. from 36 to 68, or from 15 degrees below to 17 degrees above temperate.

It appears likewise, that the sea when warmest is 14 degrees colder than Buxton Bath,* and 30 degrees below the heat of the human body.

During the months of June, July, and August, the sea is nearly of the same temperature with Matlock Bath, and in the succeeding months becomes still colder, so at last to form an extremely cold bath, only four degrees above the freezing point. The same latitude in the temperature of the sea will not occur in other coasts, where the shore is cold, the sea deep, and consequently not exposed in so shallow a body to the action of the sun and air.

* The heat of Buxton Bath is 82° . that of Matlock 68, according to Dr. Percival's experiments.

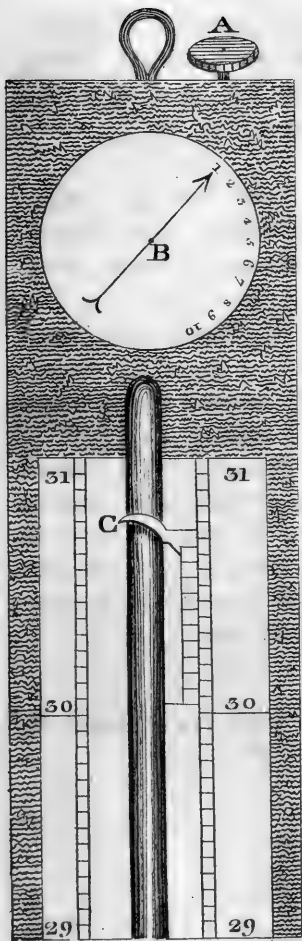


Fig. 1

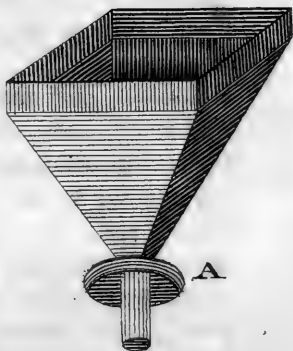


Fig. 2



LIST OF BOOKS

PRESENTED TO

THE SOCIETY.

American Academy of Arts and Sciences.

Memoirs of the American Academy of Arts and Sciences. Vol. I. Boston: 1785. 4°.

*James Anderson, L. L. D.,
F. R. and A. SS. Edin.*

Miscellaneous Observations on planting and training timber trees. Edinburgh: 1777. 8°.

Essays relating to Agriculture and Rural affairs. Third edition. 2 vols. Edinburgh: 1784. 8°.

Society of Antiquaries of London.

Account of the present
state of the Hebrides and
Western coasts of Scotland.
Edinburgh: 1785. 8°.

-Sir George Baker, Bart. F.R.S.

Archæologia. Vol. XI.
 Lond. 1794. 4^o.

Medical Transactions, published by the College of Physicians in London. 3 Vols. Lond. 1768, 8°.

Sir Richard Clayton, Bart.

Connubia Florum. Auctore
D. de la Croix: Notas &
observationes adjecit R. Clay-
ton. Bathoniæ: 1791. 8°.

A Critical Inquiry into the
Life of Alexander the Great
by the ancient Historians:
from the French of the Ba-
ron de Saint Croix. Lond.
1793. 4°.

Mr. John Dalton.

Meteorological Observa-
tions and Essays. London:
1793. 8°.

Edward Hufsey Delaval, Esq.
F. R. S.

An experimental Enquiry
into the cause of the changes
of colours in opaque and
coloured bodies. London:
1787. 4°.

Ricerche sperimentali sulle
cagioni del cangiamento di
colore ne' corpi opachi e co-
lorati trasportate in Italiano
da Gio. Francesco Fromond.
Milano: 1779. 8°.

John Talbot Dillon, Knt.
B. H. R. E.

Travels through Spain.
London: 1782. 4°.

History of Peter the Cruel.
2 vols. Lond. 1788. 8°.

Historical and critical Me-
moirs of the General Revo-
lution in France, in the year
1789. London: 1790. 4°.

Rev. James Douglas, F. A. S.

A dissertation on the An-
tiquity of the Earth. Lond.
1785. 4°.

Capt.

- Capt. John Drinkwater.* History of the late siege of Gibraltar. I & II Edit. Lond. 1786. 4°.
- Royal Society of Edinburgh.* Transactions of the Royal Society of Edinburgh. Vol. II. Edin. 1790. 4°.
- A. Fothergill, M.D. F.R.S.* A new experimental inquiry into the nature and qualities of the Cheltenham Water. Bath. 1785. 8°.
- Thomas Fowler, M. D.* Medical Reports on the effects of Arsenic in the cure of Agues, Remitting Fevers and periodic Head-achs. London: 1786. 8°.
- M. B. S. Froffard.* Sermons de M. Hugh Blair, traduits de l' Anglois. II Tom. Lyon: 1784. 8°.
- Thomas Garnett, M. D.* Experiments and Observations on the Horley-Green Spaw, near Halifax. Bradford: 1790. 8°.
- William Hawes, M. D.* Transactions of the Royal Humane Society. Vol. I. Lond. 1790. 8°.
- John Haygarth, M. B. F. R. S.* An Enquiry how to prevent the Small-pox. Chester: 1784. 8°.
-
- A Sketch of a Plan to exterminate the casual Small-pox from Great Britain. 2 Vols. Lond. 1793. 8°.
- Mr. Thomas Henry, F. R. S.* An account of a method of preserving water at sea from putrefaction. Warrington: 1781. 8°.

Mr. Thomas Henry, F. R. S. Essays on the effects produced by various processes on atmospheric air. From the French of M. Lavoisier. Warrington: 1783. 8°.

Edward Holme, M. D. Dissertatio medica inauguralis de Catarrho. Auctore S. A. Deiman. Lugd. Bat: 1793. 4°.

Dissertatio physiologica inauguralis de structura et usu Vasorum Absorbentium. Auctore Edv. Holme. Lugd. Bat. 1793. 4°.

Neue Chemische Nomenclatur für die deutsche Sprache von Christoph Girtanner. Berlin: 1791. 8°.

Mr. John Holt. Characters of the Kings of England. Lond. 1794. 12°.

General View of the Agriculture of the County of Lancaster. Lond. 1794. 4°.

Thomas Houlston, M. D. A new Method of curing the Small-pox, with a specimen of miscellaneous observations on medical subjects: translated from the Latin of John Frederic Clofs, A. M. Phil. & Med. Doct. Lond. 1774. 8°.

Essay on the Liverpool Spaw-water. Liverpool: 1773. 8°.

Thomas

Thomas Houlston, M. D.

Observations on Poisons; and on the use of Mercury in the cure of obstinate Dysenteries. Lond. 1784. 8°.

A Hunter, M. D. F. R. S.

SILVA: or a Discourse of Forest Trees, &c. by John Evelyn, Esq. to which is added TERRA, a philosophical Discourse of Earth. 2 Vols. York: 1784. 4°.

Royal Irish Academy.

Transactions of the Royal Irish Academy, 1788. Dublin. 4°.

James Johnstone, M. D.

Tentamen medicum inaugurale, de aëris factitii imperio in primis corporis humani viis. Auctore Jac. Johnstone. Edinburgi: 1750. 8°.

An Essay on the use of the Ganglions of the Nerves. Shrewsbury: 1771. 8°.

A Treatise on the Malignant Angina. Worcester: 1779. 8°.

John Coakley Lettsom, M. D.
F. R. and A. SS.

History of the Origin of Medicine. Lond. 1779. 4°.

The works of John Fothergill, M. D. Lond. 1784. 4°.

John Hyacinth de Magellan,
Esq. F. R. S.

Description de quelques machines & remèdes qu'on pourroit essayer pour détruire à peu de frais les fourmis nuisibles de la Martinique en Amérique, ainsi que d'autres insectes, par M. le Baron de Hupsch. Cologne: 1780. 12°.

John

John Hyacinth de Magellan,
Esq. F. R. S.

Dei fenomeni che il
fanguè ed i vasi sanguigni
presentano nel vuoto pneu-
matico. Milano: 1783. 8°.

Description of a Glafs Ap-
paratus for making mineral
waters, &c. Lond. 1783. 8°.

An Essay towards a System
of Mineralogy, by Axel Fre-
deric Cronstedt. Second
edition. 2 Vols. Lond.
1788. 8°.

Francis Maferes, Esq. F. R. S.

Scriptores Logarithmici.
2 Vols. Lond. 1791. 4°.

E. Peart, M. D.

The generation of Animal
Heat investigated. Gainf-
borough: 1788. 8°.

On the Elementary Princi-
ples of Nature. 1789. 8°.

On Electric Atmospheres.
1793. 8°.

Mr. F. Penrose.

Letters Philosophical and
Astronomical. Plymouth:
1789. 8°.

Mr. Thomas Pole.

The Anatomical Instructor:
Lond. 1790. 8°.

Joseph Priestley, L. L. D.
F. R. S. &c.

Experiments and Observa-
tions on different kinds of
Air, and other branches of
Natural Philosophy. 3 Vols.
Birmingham: 1790. 8°.

Rev. John Radcliffe, A. M.

Bibliotheca Chethamensis.
II Tom. Mancunii: 1791. 8°.

Samuel Foart Simmons, M. D.
F. R. S.

An Account of the Life
and Writings of the late
Wm. Hunter, M. D. F. R. S.
and S. A. Lond. 1783. 8°.

Joseph

- Joseph C. Walker, Esq. M. R. I. A.* Historical Memoirs of the Irish Bards. Dublin: 1786. 4^o.
- Martin Wall, M. D.* Medical Tracts by the late John Wall, M. D. of Worcester. Oxford: 1780. 8^o.
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- Differtations on select subjects in Chemistry and Medicine. Oxford: 1783. 8^o.
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- Differtations, Letters, &c. Oxford: 1786. 8^o.
- Charles White, Esq. F. R. S.* Observations on Gangrenes and Mortifications. Warrington: 1790. 8^o.
- Thomas White, M. D.* Dissertatio medica inauguralis de Cynanche Tracheali. Auctore T. White. 1786. 8^o.
- Mr. W. Wilson.* The Post-Chaise Companion: or Traveller's Directory through Ireland. Dublin: 1786. 8^o.
- Joseph Wimpey, Esq.* Rural Improvements: or essays on the most rational methods of improving estates; accommodated to the soil, climate, and circumstances of England. Lond. 1775. 8^o.
-
- A Treatise concerning the principles of Human Knowledge; by Bp. Berkley, with remarks on each section, &c. Lond. 1776. 8^o.
-
- Letters occasioned by three dialogues concerning Liberty. Lond. 1777. 8^o.

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ERRATA.

Page 3, line 26, for "temperance" read "temperature." p. 301, l. 25, for "materie" read "materiei." p. 331, l. 7, for "as hitherto to" read "as to render it very improbable, that it should hitherto." p. 371, two last lines, for $\frac{A^n + 1}{n-1 + r^{n-1}}$, read $\frac{A^n + 1}{n-1 \times r^{n-1}}$. P. 374, l. 2, from the bottom, for $-\frac{m}{m-1} \times P^2 y^{n-2}$, read $-\frac{m}{m-1} \times P^2 y^{n-3}$. p. 375, l. 1. for $r \sqrt{\frac{m}{m-1}}$, read $r \sqrt{\frac{m}{1-m}}$. P. 377, line 10, for $\sqrt{s^2 + r^2} \times r$ read $\sqrt{s^2 + 2} \times r$. p. 381, l. 3, from the bottom, for $\sqrt{mP^2 - r^2}$, read $\sqrt{mP^2 - r^2}$. p. 383, l. 7, for $\pm \sqrt{\frac{m}{m-1}}$ read $\pm \sqrt{\frac{m}{m-1}}$ and l. 8, for $x=$, r. $z=$. P. 384, l. 3, from bottom, for $\sqrt{y^2 + \frac{r^2 - m^2}{m-1}}$ read $\sqrt{y^2 + \frac{r^2 - mP^2}{m-1}}$ P. 385, l. 6, for $\sqrt{m. \frac{r^2 - P^2}{m-1}} \times \sqrt{r^2 - mP^2}$, read $\sqrt{m. r^2 - P^2} + \sqrt{r^2 - mP^2}$. P. 391, l. 13, for $n=1$, read $n=-1$. P. 392, l. 3, from the bottom, for $r \frac{n-3}{2}$ is infinite, ly greater than p , read $r \frac{n-3}{2}$ is infinitely greater than $y \frac{n-3}{2}$; therefore y is infinitely greater than p . P. 393, l. 4, for $\frac{\dot{p}}{y}$, read $\frac{\dot{p}}{p}$. P. 394, l. 14, for $p C p$, read $n C p$. P. 396, l. 2, for $\frac{m}{m-1} \times P^2 y^{n-1}$, read $\frac{m}{y^{n-1} \times \frac{r^{n-1}}{m-1}}$

$$\frac{\frac{m}{m-1} \times P^2 y^{n-1}}{y^{n-1} + \frac{r^{n-1}}{m-1}} : \text{ P. 397, l. 16, for } v \text{ z } u, \text{ read}$$

$v =$. P. 401, l. 10, from the bottom, for, $v =$, read $v =$. P. 402, l. 2, from the bottom, for $A r$, read $A - r$. P. 404, l. 8, for $t =$ time; read $t =$ time.

$$\text{P. 405, l. 10, for } + \sqrt{\frac{m}{m-1} \times y \dot{y}}$$

$$v \sqrt{y^2 \times \frac{r}{m-1} y - \frac{m}{m-1} P^2}$$

$$\text{read } + \sqrt{\frac{m}{m-1} \times y \dot{y}} \\ v \sqrt{y^2 + \frac{r}{m-1} y - \frac{r}{m-1} P^2}, \text{ and 2 l. from}$$

$$\text{the bottom, for } + \sqrt{\frac{m}{m-1} \times y \dot{y}} \\ v \sqrt{-\frac{m}{1-m} P^2 \times \frac{r}{1-m} y - y^2},$$

$$\text{read } + \sqrt{\frac{m}{1-m} \times y \dot{y}} \\ v \sqrt{-\frac{m}{1-m} P^2 + \frac{r}{1-m} y - y^2}$$

P. 408, l. 4, from bottom, for $\frac{r^{n-1}}{q-1}$, read $\frac{r^{q-1}}{q-1}$.

$$\text{P. 409, l. 4, for } \frac{B^q + 1}{r^q} = \frac{A^n + 1}{r^n} \text{ read } \frac{B^q + 1}{r^q} = \frac{c A^n + 1}{r^n}.$$

P. 410, l. 4 from the bottom. for $r y$, read $r y^2$. P. 412, l. 11, from bottom, for $n =$, read $r =$. P. 415, l. 11,

$$\text{for "to" read "or." P. 416, l. 6, for } r \times \frac{b V}{c^2 - V^2}$$

$$\text{read } r \times \frac{b V}{V^2 - c^2}. \text{ P. 418, l. 6 from the bottom, for "the}$$

centre of force, or such parts;" read, "the centre of force, being described by a centrifugal force, or such parts." P.

419, l. 12, from bottom, for $- m A x^{n-1}$, read $- m A x^{m-1}$. P. 420, l. 3, from bottom, for m^n , read m^m .

P. 420, l. 15, for "positive," read "possible." P. 429, l. 9.

for "ædute," read "acute." P. 499, l. 2, for "another,"

read "an earthen." P. 640, l. 14, for "so at," read "so as at."

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